The Effects of Education and Family Planning Programs on Fertility in Indonesia

Gustavo Angeles, David K. Guilkey, and Thomas A. Mroz

October 2003

MEASURE Evaluation

Carolina Population Center
University of North Carolina
at Chapel Hill
123 W. Franklin Street
Chapel Hill, NC 27516
Phone: 919-966-7482
Fax: 919-966-2391
measure@unc.edu
www.cpc.unc.edu/measure

Collaborating Partners:

Macro International Inc.
11785 Beltsville Drive
Suite 300
Calverton, MD 20705-3119
Phone: 301-572-0200
Fax: 301-572-0999
measure@macroint.com

John Snow Research and Training Institute
1616 N. Ft. Myer Drive
11th Floor
Arlington, VA 22209
Phone: 703-528-7474
Fax: 703-528-7480
measure_project@jsi.com

Tulane University
1440 Canal Street
Suite 2200
New Orleans, LA 70112
Phone: 504-584-3655
Fax: 504-584-3653
measure2@tulane.edu

Funding Agency:

Center for Population, Health and Nutrition
U.S. Agency for International Development
Washington, DC 20523-3600
Phone: 202-712-4959

WP-03-73

The research upon which this paper is based was sponsored by the MEASURE *Evaluation* Project with support from the United States Agency for International Development (USAID) under Contract No. HRN-A-00-97-00018-00.

The working paper series is made possible by support from USAID under the terms of Cooperative Agreement HRN-A-00-97-00018-00. The opinions expressed are those of the authors, and do not necessarily reflect the views of USAID.

The working papers in this series are produced by the MEASURE *Evaluation* Project in order to speed the dissemination of information from research studies. Most working papers currently are under review or are awaiting journal publication at a later date. Reprints of published papers are substituted for preliminary versions as they become available. The working papers are distributed as received from the authors. Adjustments are made to a standard format with no further editing.

A listing and copies of working papers published to date may be obtained from the MEASURE *Evaluation* Project at the address listed on the back cover.

Other MEASURE *Evaluation* Working Papers

WP-03-72 Understanding Perceptions of HIV Risk among Adolescents in KwaZulu-Natal (Kate Macintyre, Naomi Rutenberg, Lisanne Brown, Ali Karim)

WP-03-71 Contrasting Primary School Outcomes of Paternal and Maternal Orphans in Manicaland, Zimbabwe: HIV/AIDS and Weaknesses in the Extended Family System (Constance Nyamukapa, Simon Gregson)

WP-03-70 The Impacts of Decentralization on Health Behaviors in Uganda (Paul Hutchinson, John Akin, Freddie Ssengooba)

WP-03-69 How and When Should One Control for Endogenity Biases? Part I: The Impact of a Possibly Endogenous Explanatory Variable on a Continuous Outcome (Gustavo Angeles, David K. Guilkey, Thomas A. Mroz)

WP-03-68 The role of user charges and structural attributes of quality on the use of maternal health services in Morocco (David R. Hotchkiss, Katherine Krasovec, M. Driss Zine-Eddine El-Idrissi, Erin Eckert, Ali Mehryar Karim)

WP-03-67 Association of mass media exposure on family planning attitudes and practices in Uganda (N. Gupta, C. Katende, R. Bessinger)

WP-03-66 Multi-media campaign exposure effects on knowledge and use of condoms for STI and HIV/AIDS prevention in Uganda (R. Bessinger, C. Katende, and N. Gupta)

WP-03-65 The Social Side of Service Accessibility (B. Entwisle, A. Weinberg, R.R. Rindfuss, and K. Faust)

WP-03-64 Comparative Analysis of Program Effort for Family Planning, Maternal Health, and HIV/AIDS, 30 Developing Countries (J.A. Ross)

WP-03-63 Assessment of a Capture-Recapture Method for Estimating the Size of the Female Sex Worker Population in Bulawayo, Zimbabwe (S.S. Weir, D. Wilson, P.J. Smith, V.J. Schoenbach, J.C. Thomas, P.R. Lamptey, and J.T Boerma)

WP-02-62 Socioeconomic Status, Permanent Income, and Fertility: A Latent Variable Approach (K.A. Bollen, J.L. Glanville, and G. Stecklov)

WP-02-61 The Effect of Facility Characteristics on Choice of Family Planning Facility in Rural Tanzania (S. Chen, D. K. Guilkey)

WP-02-60 Health Program Effects on Individual Use of Services (Amy O. Tsui, Festus Ukwuani, David Guilkey, and Gustavo Angeles)

WP-02-59 Health Facility Characteristics and the Decision to Seek Care (E. Jensen, J. Stewart)

WP-02-58 HIV impact on mother and child mortality in rural Tanzania (Japheth Ng'weshemi, Mark

Urassa, Raphael Isingo, Gabriel Mwaluko, Ngalula J, J Ties Boerma, Marston M, Basia Zaba)

WP-02-57 Secretive females or swaggering males? An assessment of the quality of sexual partnership reporting in rural Tanzania (Soori Nnko, J Ties Boerma, Mark Urassa, Gabriel Mwaluko, Basia Zaba)

WP-02-56 Understanding the Uneven Spread of HIV within Africa: Comparative Study of Biological, Behavioral and Contextual Factors in Rural Populations in Tanzania and Zimbabwe (J Ties Boerma, Constance Nyamukapa, Mark Urassa, Simon Gregson)

WP-02-55 Assessment of the Roll Back Malaria Monitoring and Evaluation System (Kate Macintyre, Erin Eckert, Amara Robinson)

WP-02-54 Measuring Family Planning Sustainability at the Outcome and Program Levels (Rob Stephenson, Amy Ong Tsui, Rodney Knight)

WP-02-53 An Assessment of the Quality of National Child Immunization Coverage Estimates in Population-based Surveys (Jennifer Brown, Roeland Monasch, George Bicego, Anthony Burton, and J. Ties Boerma)

WP-02-52 Determinants of Contraceptive Method Choice in Rural Tanzania between 1991 and 1999 (Susan Chen and David K. Guilkey)

WP-02-51 Estimation of levels and trends in age at first sex from surveys using survival analysis (Basia Zaba, Ties Boerma, Elizabeth Pisani, Nahum Baptiste)

WP-02-50 The Impact of Community Level Variables on Individual Level Outcomes: Theoretical Results and Demographic Applications (Gustavo Angeles, David K. Guilkey and Thomas A. Mroz)

WP-02-49 The Impact of a Reproductive Health Project Interventions on Contraceptive Use in Uganda (Katende C, Gupta N, Bessinger)

WP-02-48 Decentralization in Tanzania: the View of District Health Management Teams (Paul Hutchinson)

WP-02-47 Community effects on the risk of HIV infection in rural Tanzania (Shelah S. Bloom, Mark Urassa, Raphael Isingo, Japheth Ng'weshemi, J. Ties Boerma)

WP-02-46 The Determinants of Fertility in Rural Peru: Program Effects in the Early Years of the National Family Planning Program (Gustavo Angeles, David K. Guilkey and Thomas A. Mroz)

WP-02-45 Cost and Efficiency of Reproductive Health Service Provision at the Facility Level in Paraguay (Gustavo Angeles, Ruben Gaete and John F. Stewart)

WP-02-44 Decentralization, Allocative Efficiency and Health Service Outcomes in the Philippines (J. Brad Schwartz , David K. Guilkey and Rachel Racelis)

WP-01-43 Changes in Use of Health Services During Indonesia's Economic Crisis (Elizabeth Frankenberg, Bondan Sikoki, Wayan Suriastini, Duncan Thomas)

WP-01-42 Contraceptive Use in a Changing Service Environment: Evidence from the First Year of Indonesia's Economic Crisis (Elizabeth Frankenberg, Bondan Sikoki, Wayan Suriastini, DuncanThomas)

WP-01-41 Access as a Factor in Differential Contraceptive Use between Mayans and Ladinos in Guatemala (Eric Seiber and Jane T. Bertrand)

WP-01-40 Dimensions of Ratings of Maternal and Neonatal Health Services: A Factor Analysis (Rodolfo A. Bulatao and John A. Ross)

WP-01-39 Do Health Services Reduce Maternal Mortality? Evidence from Ratings of Maternal Health Programs (Rudolfo A. Bulatao and John A. Ross)

WP-01-38 Economic Status Proxies in Studies of Fertility in Developing Countries: Does the Measure Matter? (Kenneth A. Bollen, Jennifer L. Glanville, and Guy Stecklov)

WP-01-37 A Pilot Study of a Rapid Assessment Method to Identify Areas for AIDS Prevention in Cape Town, South Africa (Sharon S. Weir, Chelsea Morroni, Nicol Coetzee, John Spencer, and J. Ties Boerma)

WP-01-36 Decentralization and Local Government Health Expenditures in the Phillippines (J. Brad Schwartz, Rachel Racelis, and David K. Guilkey)

WP-01-35 Decentralization and Government Provision of Public Goods: The Public Health Sector in Uganda (John Akin, Paul Hutchinson and Koleman Strumpf)

WP-01-34 Appropriate Methods for Analyzing the Effect of Method Choice on Contraceptive Discontinuation (Fiona Steele and Siân L. Curtis)

WP-01-33 A Simple Guide to Using Multilevel Models for the Evaluation of Program Impacts (Gustavo Angeles and Thomas A.Mroz)

WP-01-32 The Effect of Structural Characteristics on Family Planning Program Performance in Côte d'Ivoire and Nigeria (Dominic Mancini, Guy Stecklov and John F. Stewart)

WP-01-31 Socio-Demographic Context of the AIDS Epidemic in a Rural Area in Tanzania with a Focus on People's Mobility and Marriage (J. Ties Boerma, Mark Urassa, Soori Nnko, Japheth Ng'weshemi, Raphael Isingo, Basia Zaba, and Gabriel Mwaluko)

WP-01-30 A Meta-Analysis of the Impact of Family Planning Programs on Fertility Preferences, Contraceptive Method Choice and Fertility (Gustavo Angeles, Jason Dietrich, David Guilkey, Dominic Mancini, Thomas Mroz, Amy Tsui and Feng Yu Zhang)

WP-01-29 Evaluation of Midwifery Care: A Case Study of Rural Guatemala (Noreen Goldman and Dana A. Glei)

WP-01-28 Effort Scores for Family Planning Programs: An Alternative Approach (John A. Ross and Katharine Cooper-Arnold)

WP-00-27 Monitoring Quality of Care in Family Planning Programs: A Comparison of Observation and Client Exit Interviews (Ruth E. Bessinger and Jane T. Bertrand)

WP-00-26 Rating Maternal and Neonatal Health Programs in Developing Countries (Rodolfo A. Bulatao and John A. Ross)

WP-00-25 Abortion and Contraceptive Use in Turkey (Pinar Senlet, Jill Mathis, Siân L. Curtis, and Han Raggers)

WP-00-24 Contraceptive Dynamics among the Mayan Population of Guatemala: 1978-1998 (Jane T. Bertrand, Eric Seiber and Gabriela Escudero)

WP-00-23 Skewed Method Mix: a Measure of Quality in Family Planning Programs (Jane T. Bertrand, Janet Rice, Tara M. Sullivan & James Shelton)

WP-00-21 The Impact of Health Facilities on Child Health (Eric R. Jensen and John F. Stewart)

WP-00-20 Effort Indices for National Family Planning Programs, 1999 Cycle (John Ross and John Stover)

WP-00-19 Evaluating Malaria Interventions in Africa: A Review and Assessment of Recent Research (Thom Eisele, Kate Macintyre, Erin Eckert, John Beier, and Gerard Killeen)

WP-00-18 Monitoring the AIDS epidemic using HIV prevalence data among young women attending antenatal clinics: prospects and problems (Basia Zaba, Ties Boerma and Richard White)

WP-99-17 Framework for the Evaluation of National AIDS Programmes (Ties Boerma, Elizabeth Pisani, Bernhard Schwartländer, Thierry Mertens)

WP-99-16 National trends in AIDS knowledge and sexual behaviour in Zambia 1996-98 (Charles Banda, Shelah S. Bloom, Gloria Songolo, Samantha Mulendema, Amy E. Cunningham, J. Ties Boerma)

WP-99-15 The Determinants of Contraceptive Discontinuation in Northern India: A Multilevel Analysis of Calendar Data (Fengyu Zhang, Amy O. Tsui, C. M. Suchindran)

WP-99-14 Does Contraceptive Discontinuation Matter?: Quality of Care and Fertility Consequences (Ann Blanc, Siân Curtis, Trevor Croft)

WP-99-13 Socioeconomic Status and Class in Studies of Fertility and Health in Developing Countries (Kenneth A. Bollen, Jennifer L. Glanville, Guy Stecklov)

WP-99-12 Monitoring and Evaluation Indicators Reported by Cooperating Agencies in the Family Planning Services and Communication, Management and Training Divisions of the USAID Office of Population (Catherine Elkins)

WP-98-11 Household Health Expenditures in Morocco: Implications for Health Care Reform (David R. Hotchkiss, Zine Eddine el Idriss, Jilali Hazim, and Amparo Gordillo)

WP-98-10 Report of a Technical Meeting on the Use of Lot Quality Assurance Sampling (LQAS) in Polio Eradication Programs

WP-98-09 How Well Do Perceptions of Family Planning Service Quality Correspond to Objective Measures? Evidence from Tanzania (Ilene S. Speizer)

WP-98-08 Family Planning Program Effects on Contraceptive Use in Morocco, 1992-1995 (David R. Hotchkiss)

WP-98-07 Do Family Planning Service Providers in Tanzania Unnecessarily Restrict Access to Contraceptive Methods? (Ilene S. Speizer)

WP-98-06 Contraceptive Intentions and Subsequent Use: Family Planning Program Effects in Morocco (Robert J. Magnani)

WP-98-05 Estimating the Health Impact of Industry Infant Food Marketing Practices in the Philippines (John F. Stewart)

WP-98-03 Testing Indicators for Use in Monitoring Interventions to Improve Women's Nutritional Status (Linda Adair)

WP-98-02 Obstacles to Quality of Care in Family Planning and Reproductive Health Services in Tanzania (Lisa Richey)

WP-98-01 Family Planning, Maternal/Child Health, and Sexually-Transmitted Diseases in Tanzania: Multivariate Results using Data from the 1996 Demographic and Health Survey and Service Availability Survey (Jason Dietrich)

The Effects of Education and Family Planning Programs on Fertility in Indonesia

Gustavo Angeles[1,2,3], David K. Guilkey[1,3,4] and Thomas A. Mroz[1,3,4]

October 2003

[1] Carolina Population Center, University of North Carolina at Chapel Hill
[2] Department of Maternal and Child Health, University of North Carolina at Chapel Hill
[3] MEASURE *Evaluation* Project, University of North Carolina at Chapel Hill
[4] Department of Economics, University of North Carolina at Chapel Hill

The authors gratefully acknowledge the support from the MEASURE *Evaluation* project, USAID Cooperative Agreement HRN-A-00-97-00018-00. The authors also acknowledge The Lembaga Demographi of the University of Indonesia for their efforts to collect part of the data used in this study. In particular the authors acknowledge and thank Drs. Sri Haritaji Hatmadji and Omas Bulan Rajagugkguk for their help with the data. We appreciate the many useful comments made on earlier drafts of this paper at the University of Pennsylvania, Johns Hopkins University, and by participants of the 2001 IUSSP meetings, especially Ronald Lee and Mark Montgomery.

ABSTRACT

Numerous studies indicate that female education is a major determinant of completed family size and the length of the interval between births. The estimated reductions of fertility rates due to increases in education typically dwarf the effects of most other variables, including variables included to measure the availability of family planning programs. Based on such estimates, some analysts have concluded that programs to increase women's educational attainments might be the most effective way to stimulate reductions in fertility in developing countries. There are, however, two serious deficiencies in the research relating educational attainment to fertility that could give rise to invalid inferences about the causal impacts of education. First, many public programs, including health and family planning programs, may influence a woman's decisions about education, and these indirect programmatic effects might be large. Second, nearly all existing studies of the impacts of education on fertility assume that a woman's educational attainment is unrelated to other unobserved determinants of these outcomes. Education could be serving as a proxy for such unobservable determinants as ability, motivation, and parental background, as these factors most likely are important determinants of a woman's educational attainment. The estimated impact of education on fertility most likely includes the impacts of these unobserved factors as well as the true education effect. In our empirical work, we use the 1993 Indonesian Family Life Survey (IFLS). We compare the estimated impacts of education on fertility from a simple model that assumes the exogeneity of education and an unobserved factor model that allows for endogeneity of schooling. Our empirical results provide key evidence that the importance of female education as means of reducing fertility would be overstated for Indonesia if one uses a naive empirical model that does not control for endogeneity due to the self-selection of a woman's educational status.

I. Introduction

Almost all studies of the impact of education on fertility find that the estimated reductions of fertility rates associated with increases in education levels dwarf the effects of most other explanatory variables, including those variables measuring the presence of family planning programs. Additionally, research on other family developmental measures such as children's schooling and health indicate a strong association between a mother's education and beneficial outcomes for her children. Based on such estimated relationships, many analysts have concluded that programs to increase women's educational attainments might be the most effective way to stimulate reductions in fertility and improve children's lives in developing countries. There are, however, two serious deficiencies in nearly all empirical research relating educational attainment to fertility that could give rise to invalid inferences about the causal impacts of education. First, many public programs, including family planning programs, may influence a woman's decisions about education or age at marriage, and therefore they might have large indirect effects. Second, few studies have controlled for the possible endogeneity of education that could arise because those individuals who complete more schooling might be a self-selected sample. In this paper we address both of these issues in the context of an evaluation of the roles mother's education and family planning programs play in lowering fertility in Indonesia.

We address the relevance of such endogeneity problems in the context of a model of the impact of education and family planning programs on fertility using detailed, retrospective information available in the 1993 Indonesia Family Life Survey (IFLS) supplemented with historical statistics describing regional and temporal variations in school quality. Like much of the literature assessing how controls for potential confounding influences affect the estimates of the importance of female education on child outcomes, we find that failing to address the potential for endogeneity in our sample appears to yield overestimates of the importance of a woman's education for reducing her fertility. The estimated direct effects of education, in fact, suggest that higher education levels are associated with high hazard rates of conceptions. The presence of family planning programs in a woman's village, especially if they have been in place for several years, appear to yield significant fertility reductions.

Our empirical approach also allows us to examine both the direct effects of family planning programs on fertility and the indirect effects through education. We find that the presence of family planning programs in a young woman's village when she is making her school attendance decisions increases her educational attainment. Overall, simulation results indicate that enhanced school characteristics provide only small incentives for women to attain more schooling[1] while the introduction of family planning programs appear to have important impacts on both educational attainment and fertility.

II. Background

At least since the pioneering work by Becker (1960) on the interactions of education and fertility, economists have considered a woman's education level to be a proxy for her shadow value of time. Since raising children is thought to be a time intensive good, as female education levels rise one would expect to see families substitute out of children and into relatively less expensive, market purchased goods. This simple argument, of course, abstracts from possible income effects from the education increases that could counter this substitution effect. But most analysts appear to have accepted the argument, from a static model, that the substitution effect should

[1] This assessment is in line with Duflo's (2002) estimate that the dramatic increases in school construction in Indonesia during the 1970's (almost 2 new schools per 1000 children) lead to only about one quarter of a year increase in the number years of education completed there by young men.

dominate the income effect because the presence of children would tend to remove women from the paid labor force and thereby nullify the income effect.

There could be many other pathways through which female education affects fertility besides through the substitution effect. For example, education may impart skills, like literacy, that can help to alter how women perceive their role in society. Highly educated women might have more bargaining power when making contraceptive decisions within their families. Since women often wait until they have left school to begin families, staying in school longer postpones the age at first childbearing and thereby can lower the total fertility rate. Bledsoe, Johnson-Kuhn, and Haaga (1999) and Eloundou-Enyegue (1999) provide brief overviews of many of the mechanisms that could help to link higher education to lower fertility.

The accumulated empirical evidence in developing countries indicated that female education was associated with lower levels of fertility. This evidence had important policy implications. A 1992 World Bank Development Brief discussing the important gains from educating girls, for example, compared the efficiency of family planning and education programs for lowering fertility:

> "Educated women also choose to have fewer children. And extra year of female schooling reduced female fertility by about 5% to 10%. So, a $30,000 investment in educating 1,000 women would avert 500 births. How much does the typical family planning program spend to avert one birth? About $65. Averting 500 births would cost about $33,000, the same as educating an additional 1,000 girls, enough to justify education on family planning grounds alone."

Such conclusions "do not necessarily represent the views of the World Bank and its member countries," but the background paper for this Brief was written by World Bank's Chief

Economist and Vice President for Development Economics at that time (Summers, 1992) so it surely carried considerable weight.

The evidence on the inverse relationship between women's education and fertility, however, is subject to several important qualifications. Jejeebhoy (1996), for example, finds for less developed countries with high levels of gender stratification that slight increases in education starting from low education levels can lead to increases in fertility. Only in the more developed countries do increases in education among those with the lowest education levels consistently yield fertility declines.

Others have questioned whether one can conclude that there is a causal relationship between higher education levels and lower fertility. In a recent paper using data from South Africa, Thomas (1999) examines the effects of female education on fertility. He notes that "the evidence does indicate that a naive causal interpretation of the magnitude of the association is probably flawed and that failure to take account of the selection process underlying educational attainment is likely to lead to substantially incorrect inferences." Diamond, Newby, and Varle (1999) also suggest that the lower fertility rates of more educated women may reflect selection rather than a causal effect of education.

While many authors have recognized the self selectivity of educational attainment (see Behrman, 1990, and Strauss and Thomas, 1995 for literature reviews), few authors have explicitly controlled for its endogeneity when it is used to explain fertility or related outcomes. There have, however, been several studies examining the robustness of the estimated impacts of education on labor market and child outcomes. Behrman and Birdsall (1983) study the impacts of education on wages in Brazil. They use a simple Mincer schooling choice model augmented by variations in school quality. Their theoretical model suggests that if higher school quality leads to more education, then there will tend to be overestimates of the impact of schooling on wages when one ignores the quality dimension. Their empirical analysis strongly supports this theoretical implication; the impact of years of school on wages falls by almost one half after they control for school quality. Angeles (1997) found that controlling for the endogeneity of education reduced the estimated return to schooling on labor market outcomes by nearly one half in Peru. Duflo (2000) in a study of the returns to education in Indonesia, however, finds that the estimated returns to education either remain unchanged or increase slightly after controlling for the endogeneity of individuals' schooling. Behrman and Rosenzweig (2002), in a somewhat different context, find that controlling for the endogeneity of a mother's education level changes the sign of the impact of her education on her children's educations from positive and significant to negative and insignificant.

The literature examining the indirect effects of family planning programs is less well-developed. In part, this is due to data limitations arising from the relatively recent introduction of wide-scale family planning programs. Only during the past decade would one have been able to link data on family planning programs to women's education and their subsequent fertility. Angeles, Guilkey, and Mroz (1998) in a study for Tanzania show that access to family planning programs early in a woman's life can have lasting effects on her fertility in addition to the effects of current access to family planning facilities. They did not, however, specify the mechanisms that could result in these long-tem impacts. In a study of Bangladesh, Foster and Roy (1997) find important family planning program effects on reducing women's fertility and increasing their children's education associated with the Matlab experiment. This study had the advantage of being able to treat program inputs exogenously, but their data are not of sufficient duration to trace through the effects of these higher education levels on the children's subsequent fertility behaviors.

In the absence of experiments like the Matlab interventions, when assessing program impacts it is important to determine whether the provision of programs to particular areas might have been governed by location specific factors that are related to the outcomes of interest. If the programs are targeted with their presence being associated with characteristics unobserved by the researcher, there could be important biases in studies that simply relate outcomes to the presence of programs. Rosenzweig and Wolpin (1986) demonstrate that the impact of public programs could be seriously biased if unobserved characteristics of the program distribution mechanism are correlated with outcome variables such as health and fertility.

Angeles, Guilkey, and Mroz (1998) develop an empirical model of life cycle fertility that accounts for individual heterogeneity as well as modeling the endogenous determination of family planning services in communities in Tanzania. Their empirical modeling approach recognizes that there might be particular unmeasured features of communities that could be related to the fertility of women within the community as well as to the propensity for the government to place family planning programs within the community. Their results indicate that such selective placement of family planning programs does have important effects on a researcher's ability to measure the programmatic effects. Without controlling for the endogeneity of the placement of the family planning facilities, they found that hospitals were the most important type of facility for providing effective family planning services. After controlling for the endogeneity of the timing of the placement of the programs, they found that hospitals providing family planning services had little impact on individual fertility outcomes, while health centers providing family planning services appeared to have large fertility reducing effects.

Gertler and Molyneaux (1994) and Pitt, Rosenzweig, and Gibbons (1993) note the targeted nature of the Indonesian family planning program and estimate fixed effects models to measure the impact of family planning programs on fertility. Gertler and Molyneaux's major conclusion is that, after controlling for program endogeneity, program effects on fertility are not significant even though simple methods indicate a significant negative impact on fertility for health centers. Pitt, Rosenzweig, and Gibbons, on the other hand, find that simple methods yield a significantly *positive* impact for family planning programs on fertility. The effect becomes negative but insignificant when the endogeneity of program placement is controlled. Endogeneity of program placement in Indonesia could certainly be an important issue.

The Gertler and Molyneaux (1994) and Pitt, Rosenzweig, and Gibbons (1993) studies examine program impacts over a five or six year period in the early 1980s. This time period is almost 10 years after the initiation of the Indonesian family planning program. In addition, a massive expansion of the educational system in Indonesia also took place in the 1970s and early 1980s. Both papers examine change in fertility as a function of program changes during a period in which change was much more gradual than it had been earlier. This lack of variability might explain why the two studies were unable to uncover significant estimates of the program impacts.

In this paper, we examine a much longer period of time that starts near the beginning of the expansion of services in Indonesia in the 1960s and ends in 1993. Our methodology allows us to examine annual decisions made by women as a function of the current and past program environment. We can match better the timing of the introduction of services to fertility decisions made by respondents—a factor that we found to be crucial in uncovering program effects in both Tanzania and Peru.

III. A Theoretical Framework

Goldin and Katz (2000, 2002) present a simple model of how improvements in contraceptive technology can lead to changes in the career choices, the timing of marriage, and age at first birth. The underlying assumption in their model is that better contraception makes premarital sex less "risky" because it prevents most unplanned pregnancies. This reduces the implicit cost of delaying marriage, and by assumption there is then more room for women to invest in careers and in finding a more suitable spouse. They use the introduction of the pill in the early 1960s in the U.S. as a signal of improved contraceptive technology, and they find widespread support for their model's basic implication.

We extend their simple framework by adding several additional features to the model. The Goldin-Katz model is somewhat silent on the issue of why those who delay marriage might want to invest in schooling rather than work and increase their disposable income. A realistic and important way to provide an incentive for investments in human capital would be to allow for women to possibly work after marriage.

We assume a three period model. At time T-2 women make schooling decisions. When making this decision a woman recognizes that her market wages when married will be higher, but when she has more children she will have less time to devote to working and earning income. At time period T-1, after making her schooling decision[2] at T-2, she makes a decision about contraception. We allow for the costs of contraception to depend on the woman's knowledge of contraceptives, where this knowledge can be provided by there being family planning services available in her community. The schooling decision made at T-2 depends on the woman's

[2] The division between periods T-2 and T-1 is artificial and is used primarily for expository purposes. All decisions made at T-2 are done with full knowledge of what the decisions will be at T-1 conditional on the decisions made at T-2.

knowledge of contraceptives in this dynamic model.

At the start of time period T, a random number of children are born, where the distribution depends on the level of contraceptive efforts made at T-1. After learning how many children she has, the mother makes decisions about how much labor to supply to the formal labor market. The previous schooling and contraceptive effort decisions recognized that the woman would be making these labor supply decisions. This model ignores time discounting because none of its main implications depend on the degree of time preference as long as there is not perfect myopia.

To be concrete, suppose at date T that a woman chooses how many hours to work in the labor market, h_{MT} , at wage w(s), and how many hours to devote to home production, h_{PT}, where her wage rate depends on her level of schooling, s. We assume she must also commit to spend c hours with each of her children. The husband's income, y_T , and his home production, g_{HT} , are assumed to be exogenous in this model, and we assume that the utility function depends on the sum of market purchased goods, x_T, and home produced goods, g_{PT}, and separably on the number of children in the household. At date T, after learning how many children she has, K_T, the woman with s years of school maximizes

$$W_T(K_T, s) = U_T(g_{HT} + x_T + g_{PT}) + F_T(K_T) \tag{1}$$

subject to the time constraint

$$\overline{L} = h_{MT} + h_{PT} + cK_T , \tag{2}$$

the household production constraint

$$g_{PT} = g(h_{PT}) , \tag{3}$$

and the budget constraint

$$x_T = y_T + w(s)h_{MT} . \qquad (4)$$

$\overline{L}$ is the total amount of time available to the woman, and g(.) is the production function for home produced goods, with g'>0 and g"<0. F_T(.) is assumed increasing in its argument (i.e., the number of children) at a decreasing rate, as is the function w(s) that relates wages to schooling.

The first order conditions for a maximum, assuming an interior solution, imply that

$w(s) = g'(\overline{L} - cK_T - h_{MT})$. Since the wife's schooling level is fixed at the start of T, this first order condition implies that the woman will choose to reduce her hours of work by c hours for each child she has. Note that if K_T is large enough, then it can be the case that

$w(s) < g'(\overline{L} - cK_T - 0),$ and the woman will choose a corner solution and work zero hours. For each family size K_T, we can solve for the woman's optimal market labor supply as

$$h_{MT}(K) = \max\left\{0, \overline{L} - cK_T - g'^{-1}(w(s))\right\} \qquad (5)$$

Inserting this optimal labor supply choices into the utility function yields the optimal utility to the woman if she enters time period T with K children. Let $W_T^*(K,s)$ be this maximal utility.

We make several assumptions directly about this optimal value function defined at the start of period T. Note that rather than imposing these assumptions on $W_T^*(K,s)$, we could instead impose assumptions of the underlying functions U(.), g(.), F(.) and w(.). Our first assumption is that, for each level of schooling, s, there exists an optimal quantity of children, $K_T^*(s)$. This means that if the parent were able to choose K_T without cost after knowing her schooling level that she would choose exactly this quantity. It is her "ideal number of children." This assumption is innocuous, given that there is a tradeoff between the higher direct utility from additional children ($F(K_T)$) and the loss in labor market income due to the increased time constraints for the mother by having additional children.

It is important to note, in this model, that it is not necessarily the case that those with higher schooling levels would necessarily choose to have fewer children if they could costlessly choose to do so. Assuming an interior solution for hours of work, an additional child would cause a mother to give up $c \cdot w(s)$ units of consumption. Since those with higher schooling levels have higher wages, it is certainly the case that higher educated women would have to give up more consumption in order to have an additional child. However, those with higher schooling levels and wages would have higher aggregate goods consumption levels for all possible numbers of children. Thus, even with a larger absolute loss of labor income because of an additional child, the consumption utility loss could be smaller when education levels are higher. Since the benefits from having an additional child do not depend on the mother's education level, it is possible for the more educated to have a larger ideal number of children than the less educated. Our model allows for the possibility that the income effect in the demand for children need not be small relative to the substitution effect.

Next we assume that there exists for each education level a number of children, $\overline{K}(s)$, such that if the mother has at least this number of children then her optimal labor supply decision would be to not work. For all $K_T < \overline{K}(s)$ she would choose to spend some time in the labor market. This assumption implies that for all values of $K_T \geq \overline{K}(s)$ that the optimal value function does not depend on the mother's schooling level. Note that the optimal value function $W_T^*(K,s)$

is increasing in s for all $K_T < \overline{K}(s)$. This particular form of the simplifying assumption is not crucial. At the cost of additional notation and algebra we could instead replace it with an assumption that the value of education falls as the number of children becomes large along with a fixed cost of working.

In order for there to be an interaction between schooling and desire to control fertility, we also assume that the "ideal" number of children, $K_T^*(s)$, is less than $\overline{K}(s)$ for at least one level of schooling. Without this type of assumption in the model there would be no gain from increased education, even if the woman were guaranteed her ideal number of children. In fact, given the setup of this simple model, if the woman's ideal number of children were always quite high for all education levels, she would never have an incentive to invest in her own schooling even if she could costlessly achieve her ideal family size.

At time period T-1 the woman makes a contraceptive choice decision. We assume that each woman can and will bear at least her ideal number of children. The role of contraception in this model, then, is that it can help to prevent the woman from overshooting her ideal number of children. This simplification does have some potentially important implications. In a more dynamic model, where a woman always optimally adjusts her contraceptive efforts to reflect her age and family size (e.g., David and Mroz, 1989a, 1989b; Mroz and Weir, 1990), there can be costs from using contraception because it can increase the probability that a woman will fail to reach her ideal number of children. Here we ignore such potential costs.

Under this assumption, at time period T-1 the woman maximizes

$$
\begin{aligned}
V_{T-1}(s;\theta) &= D(b;\theta) + E_{T-1}W_T^*(K_T,s) \\
&= D(b;\theta) \\
&\quad + b\,W_T^*(K_T^*(s),s) + (1-b)\,E_{T-1}W_T^*(K_T,s \mid K_T > K_T^*(s))
\end{aligned}
\tag{6}
$$

where b represents contraceptive efforts to prevent the woman from bearing more than her ideal number of children, and we express these efforts in terms of the probability that she bears exactly her ideal number of children. We are assuming that increased contraceptive effort reduces the probability of each value of $K_T > K_T^*$ by the same proportion. The perhaps more realistic assumption that contraceptive efforts increasingly reduce the relative probabilities of having an additional child might strengthen the implications of the model.

There is a utility cost of contraception, $D(b;\theta)$, with the utility cost of contraception increasing at an increasing rate, i.e., D'<0 and D">0, holding θ fixed. This cost depends upon the parameter θ, which indexes the woman's knowledge about contraception. We assume that the marginal utility cost of increased contraceptive effort is high when contraceptive knowledge, θ, is low, i.e., $\partial^2 D / \partial b\, \partial\theta > 0$.

The first order conditions for a maximum at T-1 imply

$$D'(b;\theta) = E_{T-1} W_T^*(K_T, s | K_T > K_T^*(s)) - W_T^*(K_T^*(s), s) \qquad (7)$$

or that the woman will increase her contraceptive efforts up to the point where the increased cost of contraception just equals the loss the woman would experience by overshooting her ideal number of children. Recall that we assumed that when contraceptive knowledge θ is low, for all possible contraceptive effort levels b the marginal cost is higher than when contraceptive knowledge is high. This assumption just states that it is easier (less costly) to prevent births when on has more knowledge about contraception. This assumption about contraceptive costs does have one important implication, namely, that at every education level those with more contraceptive knowledge will choose to use more contraception (choose high values of b) than those with less contraceptive knowledge. Women with more contraceptive knowledge will be less likely to give birth to more than their ideal number of children. Solving (7) for the optimal contraceptive effort and substituting this relationship into (6) yields the optimized expected utility from T-1 onwards as a function of s and θ. Let $V^{*}_{T-1}(s;\theta)$ be this optimized value function.

At period T-2 the woman makes her optimal schooling decision. When doing this, she recognizes her contraceptive knowledge and assumes that all future decisions will be optimal given the information available at the time the decisions are to be made. Let -Q(s) be the contemporaneous disutility associated with obtaining education level s. This can incorporate any direct disutility of schooling as well as the opportunity costs of time spent in school and any direct costs of schooling. We assume Q'(s) > 0 and Q''(s) > 0. The optimization problem at time T-2 is to maximize (8) with respect to s,

$$-Q(s) + V^{*}_{T-1}(s;\theta) \quad , \tag{8}$$

where the first order conditions imply

$$Q'(s) = \frac{\partial V^{*}_{T-1}(s;\theta)}{\partial s} . \tag{9}$$

The basic implication from first order condition (9) is that a woman will incur costs of schooling up to the point where the future gain from additional schooling is just offset by the cost of the additional schooling.

The key issue here is how increased contraceptive knowledge can affect the optimal choice of schooling. First, note that increased contraceptive knowledge will allow the woman to reduce the probability of overshooting her ideal number of children. By choosing a larger value of b in equation (6), weight will shift to the higher value function in that equation which is associated with achieving exactly one's ideal number of children. Increases in contraceptive knowledge clearly lead to increases in utility. In the context of this model higher contraceptive knowledge will result in lower fertility by reducing the probability of exceeding one's ideal number of children.

Second, examination of (9) reveals that if higher levels of contraceptive knowledge, θ , yield larger future gains from increased schooling, then increases in contraceptive knowledge will tend to be followed by increases in educational attainments. In particular, increased contraceptive knowledge will induce women to invest in more schooling provided that

$$\frac{\partial^2 V^*_{T-1}(s;\theta)}{\partial s\,\partial\theta} > 0.$$

In combination with the assumption on increasing costs of schooling, if the above inequality is satisfied then increased contraceptive knowledge will result in higher educational attainments.

What is key here, however, is not just higher levels of contraceptive knowledge increase the value of education. This is a necessary condition for more contraceptive knowledge to increase the level of the optimal schooling decision, but it is not sufficient. In order for increased contraceptive knowledge to lead to increased schooling, it is also necessary that the increased returns to schooling be larger for those with higher schooling levels. In the context of this simple economic model, the first necessary condition, $\partial V^*_{T-1}/\partial\theta > 0$ is satisfied at all schooling levels, but the second necessary condition need not be true.

To see why there is ambiguity, consider the following two scenarios. First, with low levels of contraceptive knowledge, higher education levels could have been used as an insurance mechanism to provide higher income if one exceeded the ideal number of children. With more contraceptive knowledge, there is less of a need to use education for this type of "insurance." The value of increased education becomes smaller when better contraception becomes available in this first example. Second, suppose that increased contraceptive knowledge, with no change in educational attainments, would lead those with higher education to expect to spend more additional time in the labor market than those with lower educational attainments. In this case, the monetary rewards to increased contraceptive knowledge would certainly be higher for those with higher education levels. However, given concavity of the utility function, it is not clear if the higher labor incomes for the more educated would increase their utility more than the somewhat smaller increases in labor incomes would increase the utility levels for the less well educated. Surprisingly, it need not be the case that more sure prospects for increased labor income brought about by better contraceptive knowledge or practices would lead to increases in educational attainments. That is an empirical question that needs to be resolved.

There is, however, one special case in this model when increased contraceptive knowledge will bring about an unambiguous increase in the woman's education. Suppose that when there is a low level of contraceptive knowledge that the woman's optimal educational choice would be to set the cost of education to its lowest possible level. Also, suppose that at this low education level that the woman's ideal family size is large enough to ensure that she would not want to work in the labor market. These conditions ensure that she would never work. Since education in this model is costly and only yields value if the woman works, she would always choose the lowest education possible. Prior to receiving this new contraceptive knowledge, it would have been too costly for the woman to invest in education because the probability that she would have so many children that she would choose to not work at time T would have been too high to justify the cost of education. Stated differently, there would be no income effect associated with her education.

The increase in contraceptive knowledge in this scenario reduces the probability that the woman would overshoot her ideal family for every possible education level that she could choose.

This means that it would be more likely for a woman to choose to work if she chose a higher education level. If the increase in contraceptive knowledge increases the probability of working at higher education levels by a large enough amount (i.e., by reducing the probability of overshooting her ideal family size), then the woman would chose a higher education level with the higher level of contraceptive knowledge.[3,4]

This is clearly a very simple model, but it does provide some important implications. First, better contraceptive knowledge, because it does reduce the probability of overshooting one's ideal family size, should reduce the expected number of children that would be born. This result, however, does rely somewhat on the assumption that the woman can achieve at least her ideal family size without cost. Second, it is not necessarily the case that those with higher education levels necessarily will have smaller family sizes; the economic model recognizes that there can be important income effects as well as substitution effects. Third, it need not be the case that increased contraceptive knowledge will result in women optimally choosing higher education levels. This would only be the case if the increased knowledge about contraceptives increased the utility gains for the more educated by more than it increased the utility gains for the less educated. Fourth, increases in contraceptive knowledge might have larger education impacts on those who would have chosen lower education levels in the absence of the increased knowledge. The magnitudes and directions of nearly all of these impacts on fertility are empirical questions.

---

[3] Associated with this higher education level would be an unambiguously smaller ideal family size. This effect is unambiguous because the "income effect" associated with her prior low education level was zero.

[4] This special case is analogous to a wage effect in a standard labor supply model. In the standard labor supply model, one cannot rule out the possibility that a labor supply curve "bends backwards." Only for the decision of whether to enter the labor force, when the income effect is zero, does an increase in the wages lead to an unambiguous increase in propensity to work.

A Brief Overview of the Estimation Approach

Our empirical model uses a maximum likelihood procedure to estimate the determinants of a woman's schooling, age at marriage, and fertility outcomes. Starting at age 6, each year a woman makes a decision about whether she wants to continue in school for another year. This decision depends upon year effects, her age, the quality of the schools in her local area, and indicators for how long each of three types of family planning services have been in her community of residence. It is the latter, community-level exposure to family planning variables, that we assume capture the woman's knowledge about contraceptive practices. Note that at the youngest ages we do not need that the woman actually know precisely about contraception. All that is required here is that the woman, or her parents if they are making the schooling decisions for her, believes that she will be better able control her future fertility when there have been local examples of individuals having access to contraception for controlling fertility. We allow for there to be separate effects of whether there were family planning programs in her place of residence at age 7 when she started making her education decisions, along with the more usual indicators of the current availability of family planning programs in her community. Note that the theoretical model suggested that these age 7 effects could be substantial.

We also model two characteristics of her marriage, her age at marriage and the education level of her spouse. We use a discrete time hazard approach to model the age at marriage, where marriage decisions depend on completed schooling as of that age and whether she was in school during the preceding year. Marriage decisions, like the schooling decisions, also depend on the age 7 and current exposure to facilities providing family planning. From a theoretical perspective, it is possible that better contraceptive knowledge could lead to an earlier age at marriage if delayed marriage had been used as a substitute for contraception in reducing family size. We model the years of education of the spouse as being determined by the same set of time varying and person specific variables as we used to model the woman's own education level.

The final set of outcomes we model are the woman's fertility experiences. Starting at age 10 we use an annual model whether the woman had a conception that lead to a live birth. Each of these annual outcomes depends on her age, education, current number of children, as well as characteristics of the woman's current and past exposure to family planning facilities. As for all the other outcomes, we allow the presence of family planning facilities in her place of residence when she was age 7 to have a separate impact from whether there were family planning services "currently" available in her community. We do this because we want to allow for the possibility that contraceptive "knowledge" when she was young could have helped to shape her life cycle plans about childbearing.

Given the evidence discussed above about the potential endogeneity of family planning facilities, in preliminary versions of our analysis we also controlled for the endogeneity of the timing of the placement of the facilities using an approach similar to that used by Angeles, Guilkey, and Mroz (1998). However, we didn't find evidence of endogenous placement of family planning programs. On the basis of this finding we treat the presence of family planning facilities as exogenous. We do, of course, use the detailed regional controls as determinants of all the outcomes we model.

By using a maximum likelihood framework, we are able to control for the endogeneity of the prior, individual level outcomes such as schooling, marital status, and prior births on subsequent outcomes. We do this by using discrete approximations to individual level, unobserved determinants of all outcomes as suggested by Heckman and Singer (1984), Mroz and Guilkey (1992), and Mroz (1999).

The Data Set

The main source of data for this study is the 1993 Indonesia Family Life Survey (IFLS). The IFLS is one of the few surveys available that provide detailed information on fertility, schooling, and migration histories for a representative sample of a country's population. A key feature of the IFLS is that the household survey was accompanied by community and facility surveys which provide current and retrospective information on community characteristics and availability of family planning, health and schooling facilities that are relevant for the household survey respondents. As explained below, the data set was further augmented with community-level information from other sources so that statistical identification for our multi-equation model can be obtained.

The IFLS covered 13 of the 27 provinces in Indonesia with a total of 321 randomly selected enumeration areas included in the survey. Eighty-three percent of the population of Indonesia reside in these 13 provinces. Within each province the sampling strategy involved first selecting an enumeration area, then households, and then household members. Both the male and female head of the household were interviewed while some additional household members were selected for interviews. The IFLS provides individual-level sample weights that we use for the estimation. Detailed schooling and migration information was collected for all selected women age 15 or over. In addition, detailed marriage and fertility information was collected for selected ever-married women age 49 or younger at the survey date. Our sample of analysis consists of 5,025 women age 13 to 51[5] with complete schooling, migration and marriage histories. Of them, 4,659 women were married at least once and had complete fertility histories.

[5] While most women in the analysis sample were age 15-49 at the time of the survey, there were three women age 13, 50 and 51 that responded to the ever-married fertility and marriage questionnaire. These three women were kept in the analysis sample.

Each ever married woman was asked for the month and year of birth of every birth she had. Using the information on the timing of births we reconstructed the conception histories for each woman. The dependent variable of the fertility equation was constructed by following each woman every year from age 10 until the year of the survey, 1993, and recording whether she had a conception leading to a live birth in a particular year. A total of 113,995 woman-year observations are recorded in which 15,283 conceptions occurred. Since fertility histories are collected only for a non-random subset of individuals in the IFLS, we use the sample weights included with the data for the analysis of the fertility outcomes.

Education is included in the model using dummy variables for schooling levels. The education system of Indonesia consists of primary school (6 years), junior high school (3 years), senior high school (3 years) and higher education or university (2 or more years). Using the information on woman's age and the number of years she spent in school, it is possible to backdate the information on school attainment for every year of woman's life. We assume that she entered school at age 7 and remained there until the reported number of years of education was obtained.

The IFLS recorded detailed information for birthplace, place of residence at age 12, place of last marriage, and the destination of every migration move[6] after age 12. For every migration event, women were asked the month and year of change of residence, and detailed information to identify the destination place including whether it is urban or rural. This information enables us to reconstruct the woman's place of residence for every year from age 7 until 1993. For

[6] The IFLS recorded migration moves if the change of residence involved crossing a village border line and lasted for 6 months or longer. Here, we assume that place of residence at age 7 is the same as the place of residence at age 12; we plan to experiment with alternative definitions of place of residence at age 7.

simplicity, we defined 26 regions which are the urban and rural areas of 13 geographical areas around the provinces covered by the IFLS.[7] About 31.3% of the women in the analysis sample reported at least one change in her place of residence since age 7 until 1993. The information on place of residence enables us a better match of family planning program variables and other community characteristics to the fertility and schooling histories. To help control for the impacts of migration, we include as explanatory variables the number of times the woman had moved up to each age for the events under consideration and a dummy variable indicating whether the woman was currently living in the location where she was living at the time of the 1993 survey.

The IFLS has the advantage of providing information about the communities and sources of health services relevant to the respondents of the household questionnaire. The community information was obtained by interviewing the village leader and the head of the village women's group. In addition, the IFLS visited a sample of health facilities and obtained contemporaneous and retrospective information on facility characteristics and functioning. The sampled facilities were selected from lists provided by the household survey respondents. Women in each selected household were asked to provide the name and location of facilities they knew or had used as sources of family planning or health services. For each enumeration area, the household responses were compiled to create a list of relevant facilities. A sample of them was then visited. Information was obtained for five different types of facilities or providers which we classify in three groups: government health center or auxiliary health centers, classified and *puskesmas*; private clinics, doctor offices, and practices of nurses, midwives and paramedics, classified as

[7] Very few migration movements had as destination places outside the 13 IFLS provinces and they were for a relatively short duration. Out of the 134,255 woman-year observations of the place of residence histories for the whole analysis sample, only 645 observations correspond to non-IFLS provinces.

private providers; and community health posts or *posyandu*.

A key feature of the IFLS facility questionnaire is that it recorded the year each facility first offered modern family planning services. We assume that the facility has continuously offered services since the date of first introduction. We define the family planning program variables for every type of facility as the availability of at least one facility offering family planning services to the community at any given year. A total of 993 *puskesmas*; 549 private clinics; 892 practices of nurses, midwives or paramedics; and 899 *posyandu* were included in the IFLS sample.

It is important to note that the family planning program information is only directly observed for the communities that were included as part of the IFLS. This means that we would not have time varying program information for a woman who migrated to one of these communities from a community that was not part of the IFLS for those time periods prior to her date of arrival. For these cases, we use time varying, regional averages of availability of services as proxies for the program service environment that the woman faced in those earlier years.

In order to provide additional information for the specification of our model, a special time-series data set on regional characteristics was collected from censuses, inter-census surveys and government reports. We use information on regional per capita government expenditures on development activities, regional per capita government expenditures on health, the proportion of national population in the region, regional population density, percentage of households with assets like radios in the region, and regional student-teacher ratios for primary and secondary school. The government expenditures are expressed in real terms.

The basic specification of the model includes a set of age and calendar year dummies to control for time varying factors influencing the four outcomes of the model. Appendix Table 1 presents descriptive statistics for the main variables included in the model, and Appendix Table 2 contains detailed descriptions of the variables.

Empirical Model

The main interest of this study is to examine the impacts of family planning programs on education and fertility. The model presented in this section specifies the fertility and education outcome processes in a structural way which enables us to examine the direct influence of family planning programs on fertility and the indirect effects of programs on fertility through education. We use the longitudinal modeling strategy described by Mroz and Weir (2003) to approximate the life cycle decision-making process.

Our estimation strategy also controls for the potential endogeneity of schooling in the fertility and marriage processes. Due to the characteristics of the IFLS sample, the fertility equation is estimated only for ever married women, therefore, the model includes an equation to control for potential selectivity of women into the ever married group. The model is specified to make extensive use of the fertility, schooling, place of residence, marriage and family planning program histories available from retrospective data. This approach enables one to include information on the *timing* of the introduction of family planning services and individual events, and therefore allows a better modeling of the impacts of exposure to family planning programs on women's decisions. We first present the statistical formulation of the model and then present additional details on the empirical implementation.

Fertility

The main equation of interest is the fertility equation. It is specified in the following logistic form:

$$\ln\left[\frac{Prob(B_{ijt}=1|X_{ijt}^{B},S_{ijt},P_{jt},Z_{jt}^{B},\mu_{j}^{B},\omega_{ij}^{B})}{Prob(B_{ijt}=0|X_{ijt}^{B},S_{ijt},P_{jt},Z_{jt}^{B},\mu_{j}^{B},\omega_{ij}^{B})}\right] = X_{ijt}^{B}\delta^{B} + S_{ijt}\lambda^{B} + P_{jt}\alpha^{B} + Z_{jt}^{B}\beta^{B} + \mu_{j}^{B} + \omega_{ij}^{B} \quad . \tag{10}$$

where the subscripts denote woman I from community j at time t. The dependent variable, B_{ijt}, takes the value of 1 if a conception leading to a live birth occurs for woman I in community j at year t, and 0 otherwise. The conception probability in each year is influenced by observed personal characteristics (X_{ijt}^{B}) such as the woman's age and the number of children in her family at each year, the number of years of education (S_{ijt}), the presence of family planning programs in the community (P_{jt}) and other observed community characteristics (Z_{jt}^{B}). The empirical model we estimate does incorporate time effects in order to capture systematic changes associated with time.

Fertility can also be influenced by individual characteristics that are unobserved by the researcher. The term ω_{ij}^{B} is included to capture time invariant individual heterogeneity. It represents woman-specific unobserved factors that affect the conception propensity through time like the degree of fecundability, parental background, or motivation for family-oriented or labor market-oriented activities. There may also be community characteristics, like group preferences for large or small families or the degree of support for family planning by community leaders, that also influence woman's fertility but are not observed by the researcher. They are represented by μ_{j}^{B}. The impact of any of these unobserved factors can vary through time but this possibility is ignored in this analysis.

It is likely that the unobserved factors that influence fertility (ω_{ij}^{B}) also influence level of schooling (S_{ijt}), marital status, prior fertility, and the husband's education level. If that is the case, there will be correlations between these background characteristics s and the term ω_{ij}^{B}. Estimation of (10) by simple methods, which do not control for correlation between explanatory variables and unobservables, will generate biased and inconsistent estimates. We allow for the two types of unobserved components to be potentially correlated with the unobserved factors influencing the schooling, marriage, and husband's educational attainments, and we estimate jointly the determinants of these background characteristics and the annual fertility measures. In this way we can obtain consistent estimates of the impacts of these possibly endogenous background characteristics on fertility.

For the fertility equation, we will assume that the probability of a conception is zero for years when the woman is less than 10 years of age. It is also important to note that due to the characteristics of the sample selection criteria used for the IFLS, the fertility equation is estimated only for ever married women at the time of the survey. Controls for such potential sample selectivity bias are automatically included in the model because we allow for unobserved but possibly correlated, individual level effects to influence marriage and fertility. The fertility model, then, is a discrete time, annual renewal model of conceptions leading to live births.

Education of the Woman and Her Spouse

The education equation controls for the potential endogeneity of the schooling variables in the fertility and marriage equation and enables us to measure the effect of family planning programs on education. We model education using a discrete time hazard model of continuation of school attendance. The discrete time hazard framework enables us to include time-varying information that influence the timing of schooling decisions. We assume that all women start school at age seven and attend school continuously until they reach their years of education as declared at the time of the survey. This assumption implies that women complete one grade of school for each year they attend a school. This assumption is clearly false. Unfortunately, there is no retrospective information available on the successful completion of school for each year, nor is there information on the number of years the woman actually attended school. Even if we integrated over all possible paths of grade progression and retention that could lead to the woman's stated years of school completed, we would still need to make strong and arbitrary assumptions about the underlying grade retention processes. Instead, we use this simplifying assumption.

The school attendance equation is specified as:

$$\ln\left[\frac{Prob(E_{ijt}=1|E_{ij,t-1}=1,X_{ijt}^{E},P_{jt},Z_{jt}^{E},\mu_{j}^{E},\omega_{ij}^{E})}{Prob(E_{ijt}=0|E_{ij,t-1}=1,X_{ijt}^{E},P_{jt},Z_{jt}^{E},\mu_{j}^{E},\omega_{ij}^{E})}\right]=X_{ijt}^{E}\delta^{E}+P_{jt}\alpha^{E}+Z_{jt}^{E}\beta^{E}+\mu_{j}^{E}+\omega_{ij}^{E} \quad . \tag{11}$$

where the dependent variable E_{ijt} is equal to 1 if woman I from community j at time t is in school conditional on not having terminated her schooling in the previous time period, and it is 0 if she decides not to continue attending school. The schooling continuation decision is influenced by observed personal characteristics (X_{ijt}^{E}), the presence of family planning programs in the community (P_{jt}) and other observed community characteristics (Z_{jt}^{E}) including school characteristics.

The term μ_j^E represents community unobservables that influence the schooling decision. The term ω_{ij}^E represents time invariant, woman specific factors that affect her decision to continue her schooling such as her level of motivation or parental background but are unobserved to the researcher. It is likely that there may be overlap between the unobservables that affect her fertility and schooling that is modeled by allowing the ω's in the two equations to be correlated. Formally, the schooling model is a discrete time, annual hazard model of the age (time) of leaving school. Additionally, by including this schooling outcome equation in the model one can examine the effect of family programs on education and, therefore, the indirect program effects on fertility.

We use a nearly identical approach for modeling the number of years of schooling of the woman's husband (if she marries). We use the same sets of explanatory variables and assume that the husband was exposed to the same levels of the time-dated variables that the woman would have been exposed to. In addition, we also allow the woman's level of education at the time of her marriage to be a determinant of her husband's education. Because of this, one should not interpret the husband's schooling level as true hazard process describing the decisions about when to leave school. Instead, the time-dated information on school characteristics in the husband's education model helps to describe the set of potential spouses for the woman. In preliminary studies, treating the husband's education as exogenous had only minor impacts on the estimated coefficients.

Ever Married

The IFLS recorded fertility histories only for ever married women, and so in this study only women who married at least once can be included in the analysis of fertility outcomes. As discussed above, the equation for the timing of first marriage is included to control for potential selectivity of women into the ever married group that could bias the estimates of the fertility equation. We model the event of first marriage in a discrete time hazard framework. It is specified as:

$$\ln\left[\frac{Prob(M_{ijt}=1\,|\,M_{ij,t-1}=0, X_{ijt}^{M}, P_{jt}, Z_{jt}^{M}, \mu_{j}^{M}, \omega_{ij}^{M})}{Prob(M_{ijt}=0\,|\,M_{ij,t-1}=0, X_{ijt}^{M}, P_{jt}, Z_{jt}^{M}, \mu_{j}^{M}, \omega_{ij}^{M})}\right] = X_{ijt}^{M}\delta^{M} + P_{jt}\alpha^{M} + Z_{jt}^{M}\beta^{M} + \mu_{j}^{M} + \omega_{ij}^{M} \quad . \tag{12}$$

where the dependent variable M_{ijt} is equal to 1 if the woman married for the first time at time t and equal to 0 if she has not been ever married by that year. The hazard of first marriage depends on observed individual characteristics (X_{ijt}^M), presence of family planning programs in the community (P_{jt}) and other observed community characteristics (Z_{jt}^M). Terms μ_j^M and ω_{ij}^M represent the community and individual unobservables. We control for potential sample selectivity by explicitly allowing a correlation between the individual unobservables influencing the event of marriage with those unobservables influencing the other outcomes. We assume that the probability of first marriage is zero for the years when the woman is less than 10 years of age. This is an annual, discrete time hazard model for the age at first marriage.

Equations (10) and (12), plus two versions of equation (11) (one each for the woman's and her husband's education level), are jointly estimated using maximum likelihood estimation techniques. The validity of the estimates depends crucially on the treatment of the terms representing the unobserved individual characteristics. We could, in principle, impose a parametric joint distribution for these factors, but we do not know the actual distribution of the unobserved factors. This approach also has the drawback that the distribution assumed by the researcher is arbitrary and it could misrepresent the actual distribution of the unobservables. An alternative approach is to approximate the joint distribution of the unobservables using a semi-parametric discrete factor method (Heckman and Singer, 1984; Mroz and Guilkey, 1995; Mroz, 1999). This method uses a step function with a finite number of points of support to approximate the distribution of the unobserved factors. The discrete factor method has the advantage that the parameters defining the step function (discrete distribution) are estimated jointly with the other parameters of the model. In that sense, the distributions of the unobserved factors influencing fertility, education, program service placement and marriage are estimated using all the information available on these processes. We used the non-linear version of the discrete factor method which provides more flexibility in the specification of the unobservables affecting the different processes and the correlations among them. The distribution of the individual unobservables with Q points of support is specified as:

$$Prob(\omega_{ij}^{B} = \omega_{1q}, \omega_{ij}^{E_w} = \omega_{2q}, \omega_{ij}^{E_m} = \omega_{3q}, \omega_{ij}^{M} = \omega_{4q}) = \pi_I(q) \quad , \quad for\ q = 1,2,3,...,Q \quad . \tag{13}$$

Similarly, distribution of the community unobservables with R points of support is specified as:

$$Prob(\mu_{j}^{B} = \mu_{1r}, \mu_{j}^{E_w} = \mu_{2r}, \mu_{j}^{E_m} = \mu_{3r}, \mu_{j}^{M} = \mu_{4r}) = \pi_C(r) \quad , \quad for\ r = 1,2,3,...,R \quad . \tag{14}$$

The likelihood function for each individual woman is constructed by first constructing the likelihood function for each woman conditional on the unobserved factors. By the definition of the unobserved factors, we can do this by taking the product of the likelihoods for each of the relevant individual-level outcomes at each age from age seven until 1993, conditional on particular values of the individual and community unobservable factors for each outcome. The individual likelihood function that does not condition on the individual level unobserved factor is constructed as a weighted sum of these conditional likelihoods for each individual, where the weights are the probabilities that the unobserved individual factors take on each combination of values (see (13) above). Each individual level likelihood is weighted by the sample weights provided by the IFLS.

The individual likelihoods are still conditioned on the unobserved community factors. To remove these unobserved factors, the conditional community likelihood function is obtained by multiplying the likelihood the unconditional individual likelihood functions for all individuals in the community. Then, the fully unconditional likelihood function is obtained by taking the weighted sum of the conditional community likelihoods, where the weights are the probabilities that the unobserved community factors take on their combination of values (see (14) above). We found that adding more than 10 points of support to either the individual or community level discrete factor distributions had almost no impact on the value of the likelihood function. Following Mroz's (1998) suggestion that one stop adding points of support when the likelihood value only increases trivially, we find we need to use 10 points of support for each of these two distributions.

Before turning to the discussion of the parameter estimates, it is important to understand measures we use to capture a woman's exposure to contraceptive knowledge. We consider three types of family planning programs that can provide this information at each point in time (calendar year): a *Puskesmas* providing family planning services within 5 km of the woman's village; a *Posyandu* with family planning services in her village; and a private provider of family planning services within 5 km of her village. We describe in detail the measures we use as they relate to a *puskesmas*; in the empirical model we use identical constructs to capture the impacts of *posyandu* and private providers. Angeles, Guilkey, and Mroz (1998) use similar sets of measures for the impacts of family planning programs on fertility.

The first measure is an indicator (dummy) variable for whether there was a *puskesmas* in her village. This measure, like both of the following two measures, is a time varying variable that can influence fertility, marriage, and educational outcomes during a particular year. It is the type of contemporaneous measure that is used in most studies of the impact of family planning programs on fertility.

The second family planning program measure is intended to capture the length of exposure of the woman's community to family planning programs. The motivation for this measure is the idea that the longer a *puskesmas* has been offering family planning services within a community, the more likely it is that any woman living there would know about modern contraceptive methods. A simple linear duration term would only crudely approximate this type of effect, as one would expect the impact of additional exposure to decline at higher exposure levels. To incorporate this type of diminishing effect, we use the term years/(years+d) as a regressor in each logit argument, where years measures the number of years since a *puskesmas* first started offering planning services in the village. Preliminary models suggested that setting d to 8 yielded a slightly higher likelihood function value than setting d to either 7 or 9. Note that the sum of the coefficients on the dummy variable and on this duration term measure the impact of a long-term *puskesmas* on each outcome.

The simple economic model implies that knowledge about family planning can be quite important when a woman is making her early educational decisions. The third family planning measure we use attempts to measure this exposure to family planning when the woman began making her education decisions. To do this we use a simple dummy variable for whether there was a *puskesmas* in her village when she was seven years old. We did estimate preliminary versions of this model that replaced this dummy variable for exposure at age 7 with one indicating exposure at age 10 or 12, and we found almost no substantive differences.

We also construct three similar measures of exposure to family planning programs for exposure provided by *posyandu* and for exposure provided by private providers. These nine measures capture the full range of family planning effects that we consider in this study. Note that we use these nine measures as determinants of each of the four outcomes that we model.

Estimates

Table 1 provides summary information about the model estimates. The baseline model we consider includes 259 parameters for modeling the four outcomes. 150 of these come from regional dummy variables. Using 10 points of support for each of the two heterogeneity distributions adds 90 parameters to the model, and the log-likelihood function value increases by over 1,200 points. The estimated probabilities for each point of support are also displayed in this table. While a standard Likelihood Ratio Test does not provide the correctly sized tests in this instance, it is informative to see how large an increase in the log-likelihood would be needed for one to reject the insignificance of a model with 90 additional parameters. An increase in the log-likelihood of only 75 points would indicate significance at under the 0.0001 level for an addition of 90 parameters. The addition of heterogeneity to the empirical model clearly improves the fit of the model.

The estimates of the coefficients determining the arguments to the annual probabilities of conception can be found in Table 2. The first three columns of this table come from the model that includes the heterogeneity corrections, and the last three columns pertain to the model that assumes independence. When comparing estimates from these two models, it is important to recognize that the "heterogeneity" terms are subsumed into the logistic error in the simpler model. Since a logit-type model imposes an "error" variance of $\pi^2/3$, one cannot directly compare point estimates from the two estimation procedures. Relative effects measured as ratios, however, are directly comparable. In our discussion of this table we normalize on the coefficients measuring how being age 20 differs from being age 10; this corresponds to multiplying the "naive" estimates and standard errors by 1.111 (= 4.48805/4.03874) when comparing them to the estimates that control for unobserved heterogeneity.

The coefficient on the number of children ever born by the year under consideration, ceb, measures how the woman adjusts her fertility in response to having additional children in her family. For both estimation procedures, an additional child appears to reduce the probability of a subsequent birth. The estimated impact from the model with heterogeneity controls, however, suggests a seven times larger response by couples to family building pressures. Assuming the model without the heterogeneity controls would be efficient in the absence of heterogeneity, a Hausman test indicates that the difference is statistically significant[8]. The failure to control for heterogeneity, which could include differences in fecundity as discussed in Mroz and Weir (1990), results in a severe understatement of how larger families attempt to reduce subsequent fertility, holding the woman's age constant. The coefficient on the dummy variable measuring whether the woman is currently married only increases by about ten percent after controlling for unobserved heterogeneity.

A comparison of the coefficients on the woman's education dummy variables indicates that after controlling for the endogeneity of education that those with higher education levels have higher fertility than those who did not complete primary school. In the model without the heterogeneity controls, only those with university education had higher fertility than those who did not complete primary school. Hausman tests for each of the four women's education coefficients rejects the hypothesis that these effects are equivalent in the two models, with the smallest of the four t-statistics being 3.47. The model with endogeneity controls clearly provides

---

[8] We do not correct this test for possible estimation error in the adjustment factor used to compare the models with the differing error variances. The estimated difference of the normalized coefficients is -0.197 = -0.231017+.03080(1.111) and its standard error under this assumption is $\sqrt{0.0271^2 - (0.0126 \cdot 1.111)^2}$ =0.023. In other instances where we compare coefficients across models, we use similar calculations to compute comparable estimates and standard errors of the their differences.

a much different view of the importance of increased female education as a policy tool for lowering fertility.

One possible explanation for why the endogeneity controls have such a large impact on the estimates comes from the sources of identification used to obtain the estimates from the two approaches. In the naive model, one is essentially comparing the fertility rates of those who had chosen higher education levels to those of individuals who did not complete primary school. The women who chose more education might have done so because they did not have strong (unobserved) tastes for large families, and so they knew they would have more use for human capital that would be rewarded in the labor market. In the model with the heterogeneity controls, it is the exogenous variations in the quality of the schools and in the availability of family planning that identify the impacts of higher education levels on fertility. The estimates from the model with endogeneity controls provide information about what would happen if one exogenously increased a woman's education from less than completion of primary school to a higher level. Apparently, for this type of exogenous increase in education, the income effect outweighs the effect due to the change in the value of time.

The impact of increases in the husband's education are usually associated with income effects for fertility outcomes, and we see that for both models higher values of the husband's education lead to increases in the propensity to conceive and give birth. Using the same type of Hausman test, the effects for the model that controls for unobserved heterogeneity are significantly different from those in the simple model for three of the four husband education effects. The simple model appears to overestimate the impact of the male education when moving from uncompleted primary education to completion of primary education, but it underestimates the large positive effect of increases in the husband's education at higher education levels.

The coefficients on the dummy variables indicating the contemporaneous presence of each of the three family planning programs are not significantly different from zero at conventional significance levels. Additionally, they appear to indicate that the presence of any type of facility offering family planning services leads to higher conception levels. It is, however, important to note that these coefficients cannot be interpreted without also talking into account the fact that we also control for amount of time the family planning programs had been in the community. In fact, each of the three variables measuring the number of years that family planning has been in community has a significant, negative impact on fertility. For their first year being in the community, the estimates imply that two of the three effects, those for *posyandu* and private facilities, lead to fertility reductions. After providing family planning services for at least three years, the presence of each of the three types of family planning programs appear to result in large fertility reductions.

In the limit, i.e. after the facilities have been in place for a long time, the effect of a *puskesmas* is equivalent to the fertility reduction that would be brought about by a woman aging from age 29 or 30 to being in her early to mid 30s. The effects of *posyandu* are much larger, with the estimates implying fertility reductions equivalent to the effect of a woman already having two additional children. The long-run effect of a private clinic falls between these two effects, with private clinic yielding fertility reductions just slightly larger than those induced by the woman having one more child in the family. These estimates imply substantial fertility reductions, as will be seen when we use simulations based upon these estimates to evaluate the overall impacts of the family planning programs.

The estimates associated with the presence of the family planning programs when the woman was seven years old suggest that the family planning programs are less effective at reducing fertility when they were in the woman's village when she was young. None of these three effects, however, is very large, and none is significant. Nevertheless, two of the three age 7 exposure effects do suggest that the description of the impacts in the preceding paragraph slightly overstates the importance of the family planning programs for reducing fertility.[9]

Appendix Table 3 contains the estimates associated with the woman's schooling decisions. The coefficients correspond to a discrete time, annual "hazard" of continuing in school for another year. The school quality measures operate in the expected duration, with lower student per teacher ratios and larger schools making it more likely that the youth will continue in school. These effects are larger and more significant for secondary schools, but only one of the four coefficients is significant at the 5% level.

For the most part, the family planning effects operate to increase the likelihood that the young woman continues on in school, with the three coefficients indicating contemporaneous presence of facilities and the three coefficients indicating their presence when the woman was age 7 all being positive. Only one of these is significantly different from zero. This lack of individual significance, however, is not unexpected, given that relatively few women in the data set had family planning facilities appear in their villages after they were age seven and before they left school.

Two of the three duration of exposure to family planning effects are negative, but none is significant. Despite these wrong-signed duration effects, the long-term *puskesmas* and *posyandu* effects, including the presence at age 7 effects, are equivalent to about a 60 percent reduction in

[9] The long-term coefficient impacts that do not adjust for the age 7 effects are -0.17 , -0.47, and -0.26, respectively, for *puskesmas*, *posyandu*, and private facilities. These estimates change to -0.09, -0.36, and -0.26 after adjusting for the impact of family planning services being present in one's community at age 7.

the secondary school student-teacher ratios (.24 and .28, respectively, for *puskesmas* and *posyandu* relative to -.43 for the secondary school student teacher ratio). These are not small effects. The long-term impact of private facilities offering family planning services on education is negative, but its magnitude (-0.09) is much smaller than that for the other two types of programs.

Appendix Tables 4 contains the estimates for the discrete time hazard of marriage. The endogeneity-corrected estimates imply that the women with higher schooling attainments are more likely to marry at any age than women with less education after they leave school. These education effects from the endogeneity-corrected model are monotonically increasing. They are significantly different from those in the naive model according to a Hausman test after normalizing on the estimated age 20 impacts. The long-term impacts of *puskesmas* and *posyandu* providing family planning services, including the age 7 expose measures, appear to reduce the propensity to marry, though only the *posyandu* effects is substantial (-0.41). The long-term effect of private facilities offering family planning services again has the opposite-signed effect than the *puskesmas* and *posyandu*. Its magnitude, however, is less than half that of the *posyandu* effect (-0.19).

One cannot directly interpret the husband's education estimates in Appendix Table 5 as hazards of the husband leaving school, but they do describe the education level of the woman's spouse. While the naive model implies that women with higher education always marry men with higher education levels, the endogeneity-corrected estimates suggest a weaker and often-times reverse association between the woman's education level and the education of her chosen spouse. Normalizing on the age 7 coefficients in this table, a Hausman test rejects the equality of each of the four education effects with t-statistics for the tests ranging from 15 to 34. Again the difference in these estimates is due to the fact that the naive model merely reports the association between the spouses' schooling levels, while the heterogeneity-corrected model describes how exogenous assignment of education levels to the woman would affect the education of the spouse she would marry. There appears to be considerable sorting of spouses on unobservable traits that are strongly related to education levels; this association due to unobservable factors disappears after controlling for the endogeneity of the woman's education in the determination of her husband's education. Finally, the long-term effects of exposure to family planning programs appears to result in women marrying more educated men, and better schooling environments, holding the wife's education constant, appear to result in her marrying a more highly educated spouse. From these estimates, one cannot tell if this latter effect is due to women with higher quality education choosing more highly educated mates or if the higher school quality schools in a woman's village increase the proportion of more educated men in the pool of potential spouses.

Life Cycle Simulations

While the above description of coefficients and relative effects is quite informative, it provides an incomplete picture of the effects of programs on these outcomes. In particular, because later outcomes depend on earlier endogenous outcomes, it is difficult to assess the overall impacts of schools and family planning programs on marriage, schooling, and fertility from the single equation estimates discussed above. To provide a more complete description of the overall impacts of school quality and family planning programs, we use life cycle simulations to trace out the long run impacts of these programs.

To do this, we start with each woman in the sample at age 7, select her exogenous characteristics such as place of residence and migration status, and assign her to a particular combination of school quality and family planning exposures. For each age, up to age 10 we simulate her school completion decisions using the estimates from the two empirical models. Recall that our empirical model assumes that once a woman leaves school she never returns. Starting at age 10, in addition to simulating school outcomes, we simulate marriage events and annual conceptions using the "hazard" estimates for these processes. Once she is simulated to become married, we use her characteristics at that point in time in a simulation of her husband's education level. After each year's simulation, we update all of the potentially time-varying variables for use in the subsequent year's simulation. We then average the outcomes of interest across all simulated women.

We consider two different environments for school quality and two different environments for exposure to family planning programs. For school quality, we use two different levels of the secondary school student-teacher ratio since that ratio appeared to yield the most important impacts on school outcomes. In particular, we choose a level of 17 students per teacher, roughly a the 1970 level, for the poor school quality, and 13 students per teacher, roughly the 1990 level, to describe a good school environment. For the family planning exposure measures, we use no family planning programs ever as the poor family planning environment, and for the good family planning environment we impose that all three types of family planning programs came into existence three years before the woman was born. Again, these correspond roughly to the program characteristics in 1970 and 1990.

Tables 3A and 3B provide summary measures from the simulation results for each of the four possible combinations of school quality and family planning environments. Table 3A contains the simulation results from the model using controls for heterogeneity and endogeneity, while Table 3B contains simulation results from the simple model assuming independence of the outcomes. Each table contains information on the average level of women's education, the proportion of women married, married women's mean age at marriage and their husbands' years of schooling, and the mean of the number of births per woman.

Comparing estimates in the first column of Table 3A, it appears that better schools increase average schooling attainments by about one-quarter of a year of school. This is the case regardless of the presence of family planning programs, and it is nearly the same as Duflo's (2001) average increase in schooling due to the expansions of the Indonesian school construction programs during the 1970s. Looking at the same four average education levels, it appears that the effect of long-term family planning programs on education levels is more than three times larger than the impact of the improved schools. The estimates from the simple model presented in the first column of Table 3B suggest comparable increases in education in response to improved school quality, but they suggest about 50% larger impacts of family planning programs on school completion. It is important to note that these family planning program effects, because they allow for more dynamic impacts of family planning programs than simple contemporaneous indicators for the presence of family planning programs, are much different from those most studies consider. But regardless of which set of estimates one considers, it appears that the presence of family planning programs has a large impact on women's decisions to stay in school longer.

The second columns of Tables 3A and 3B indicate that the estimated impacts of improved schools and family planning programs on marriage rates are trivial, though the changes associated with complete family planning programs do indicate about a 40% increase in the fraction of the population who never marry. The third column of the two tables reveal that improved schools are associated with about a one month increase in the age at marriage, while the institution of family planning programs appears to delay marriage by 6 months (from the simulations without endogeneity controls) to almost a year (from the simulations with endogeneity controls). The fourth column in these tables reveals a much larger impact of family planning programs on the educational level of the man the woman marries, with complete family planning programs resulting in nearly an additional year of education for the husband and better schools yielding about one quarter of a year increase in the husband's education.

The last column in each of the two Tables (3A and 3B) contain average numbers of children ever born to women throughout their fecund lifetimes in each of the four school quality and family planning environments. These estimates suggest that after controlling for the presence of family planning programs that improvements in the schools have almost no impact on women's completed fertility in Indonesia, regardless of whether or not one controls for endogeneity and unobserved heterogeneity. The estimates that do not control for heterogeneity and endogeneity in the last column of Table 3B suggest that the total impact of family planning programs is also quite small, only about 0.12 children per woman on average. However, for the model that controls for endogeneity in Table 3A, the simulations suggest that moving from an environment of no family planning programs to one where family planning programs are ubiquitous would result in a 20% decline in fertility, or nearly one fewer child per woman over the course of her lifetime. This finding that the model without endogeneity controls does not capture the large impacts of the family planning programs is a major finding of this study.

The final set of empirical results examine the consequences on completed fertility of being able to exogenously assign women to particular amounts of schooling. The simulation results from this exercise are summarized in Table 4. Using the estimates from the model that controls for unobserved heterogeneity, increasing education levels from no schooling to the completion of high school reduces completed family size by about one third child per woman. Women who attend university, however, would give birth to about 0.3 more children than those women who did not attend school. This result that higher education leads to higher fertility is not a consequence of the better educated having access to more educated potential spouses. The magnitude of this effect is about he same whether or not one controls for the level or endogeneity of the husband's education

For simulations using the estimates that do not control for endogeneity, higher education level always lead to smaller family sizes, with the reduction in fertility from no schooling to completion of senior high school being three times larger than those obtained with the estimates that control for endogenous schooling and marriage. As suggested in the discussion of the point estimates, the failure to control for the endogeneity of schooling results in serious overstatements of the usefulness of increasing women's education as a tool for reducing completed fertility.

Conclusions

This paper develops a detailed stochastic dynamic theoretical model of the interactions of knowledge about family planning practices, educational decisions, and fertility outcomes, and it uses this dynamic framework as a guide for the specification of an empirical model of individual-level education, marriage, and fertility outcomes. The theoretical model indicates that contraceptive knowledge should have impacts on schooling decisions that are made well before the woman will make contraceptive decisions that influence the number of children that she will have.

The interactions among schooling choices, family planning knowledge, and fertility are quite complex. The theoretical model indicates that the "fertility-reducing" effects that are often claimed for higher female education have only a weak theoretical justification. Similarly, it need not be the case that improvements in contraceptive technologies or contraceptive knowledge will necessarily lead women to chose to increase the amount of time they spend in school. Researchers who claim such simple relationships implicitly are making statements about the relative importance of income effects, substitution effects, and self-insurance motivations. The direction and magnitudes of the impacts of knowledge about family planning on fertility and schooling, as well as the impacts of schooling on fertility, are empirical questions.

The theoretical model provides a firm foundation for the empirical model. Most importantly, the model reveals that it is important to allow the impacts of family planning services to have longer term impacts. We incorporate such effects into our empirical specification, and we also use detailed controls for unobserved factors that could influence the schooling, marriage, and fertility outcomes. This multiple outcome, unobserved heterogeneity model allows us to control for the endogeneity of the women's education, her husband's schooling level, and her age at marriage as determinants of her life cycle fertility.

We find that the ability of higher education to reduce fertility is seriously overstated in models that do not control for the endogeneity of education and marriage. Additionally, the estimation model without endogeneity controls dramatically understates the ability of comprehensive family planning programs to provide women with the ability and desire to reduce their completed family sizes. In our primary simulations we compare the impacts of reducing secondary school student-teacher ratios by 25% to those associated with the institution of a full set of family planning programs that had been in existence since several years before a woman was born. The results indicate, for our examination of the Indonesia Family Life Survey data, that such comprehensive family planning programs have had a much larger effect for reducing fertility than had the fertility reductions brought about by substantial improvements in school quality.

References

Angeles, G. (1997). "Endogenous Schooling, Selective Migration, and the Estimation of the Returns to Education in Peru," The EVALUATION Project.

Angeles, G., D. Guilkey, and T. Mroz (1998). "Purposive Program Placement and the Estimation of Family Planning Program Effects in Tanzania," Journal of the American Statistical Association, Vol. 93, No. 433.

Angeles, G., D. Guilkey, and T. Mroz (2001). "The Determinants of Fertility in Rural Peru: Program Effects in the Early Years of the National Family Planning Program," MEASURE Evaluation Working Paper No. 46.

Becker, Gary S., (1960). "An Economics Analysis of Fertility," in Demographic and Economic Change in Developed Countries, NBER Conference Series No. 11, Princeton: Princeton University Press, pp. 209-31.

Behrman, J. (1990). "Women's Schooling and Nonmarket Productivity: A Survey and Reappraisal," The World Bank.

Behrman, J., and N. Birdsall, (1983). "The Quality of Schooling: Quantity Alone is Misleading," American Economic Review, Vol 73, No. 5, December, pp. 928-46.

Behrman, J., and M. Rosenzweig (2002). " Does Increasing Women's Schooling Raise the Schooling of the Next Generation?" American Economic Review Vol.92, No.1, pp. 323 - 334.

Bledsoe, C., J. Johnson-Kuhn, and J. Haaga (1999). "Introduction," in Critical Perspectives on Schooling and Fertility in the Developing World, Caroline H. Bledsoe, John B. Casterline, Jennifer A. Johnson-Kuhn, and John G. Haaga, eds, Washington, D.C.: National Academy Press.

David, P. and T. Mroz, (1989a). "Evidence of Fertility Regulation Among Rural French Villagers, 1749-1789: A Sequential Econometric Model of Birth-Spacing Behavior (Part 1),". European Journal of Population, Vol. 5, No. 1, pp. 1-26.

David, P. and T. Mroz, (1989b). "Evidence of Fertility Regulation Among Rural French Villagers, 1749-1789: A Sequential Econometric Model of Birth-Spacing Behavior (Part 2),". European Journal of Population, 5, No. 2, pp. 173-206.

Diamond, I., M. Newby and S. Varle, (1999). "Female Education and Fertility: Examining the Links," in Critical Perspectives on Schooling and Fertility in the Developing World, Caroline H. Bledsoe, John B. Casterline, Jennifer A. Johnson-Kuhn, and John G. Haaga, eds, Washington, D.C.: National Academy Press.

Duflo, E., (2001). "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment," American Economic Review, Vol.91, No. 4, September, pp. 795-813.

Eloundou-Enyegue, P. (1999).”Fertility and Education: What Do We Now Know?” in Critical Perspectives on Schooling and Fertility in the Developing World, Caroline H. Bledsoe, John B. Casterline, Jennifer A. Johnson-Kuhn, and John G. Haaga, eds, Washington, D.C.: National Academy Press.

Foster, A. and N. Roy (1997). “The Dynamics of Education and Fertility: Evidence from a Family Planning Experiment,” University of Pennsylvania mimeo.

Frankenberg, E. and L. Karoly (1995). “The 1993 Indonesian Family Life Survey: Overview and Field Report.” Demographic Institute University of Indonesia and RAND.

Heckman, J. and B. Singer (1984). “A Method for Minimizing the Impact of Distributional Assumptions in Econometric Models for Duration Data,” Econometrica, 52, 271-320.

Gertler, P. and J. Molyneaux (1994). “How Economic Development and Family Planning Combined to Reduce Fertility in Indonesia,” Demography 31:33-64.

Goldin, C. and L. Katz, (2000), “Career and Marriage in the Age of the Pill,” American Economic Review, Vol. 90, No.2, May, pp. 461-5.

Goldin C. and L. Katz (2002) “The Power of the Pill: Oral Contraceptives and Women’s Career and Marriage Decisions,” Journal of Political Economy, Vol 110, No. 4, August, pp. 730-70.

Jejeebhoy, S. (1996). Women’s Education, Autonomy, and Reproductive Behaviour: Experience from Developing Countries, Oxford: Clarendon Press,

Mroz, T. (1999) “Discrete Factor Approximations for Use in Simultaneous Equation Models: Estimating the Impact of a Dummy Endogenous Variable on a Continuous Outcome,” Journal of Econometrics, Vol. 92, pp.233-274, 1999.

Mroz, T., and D, Guilkey (1995). "Discrete Factor Approximations for Use in Simultaneous Equation Models with Both Continuous and Discrete Endogenous Variables," Department of Economics working paper # 95-02, October.

Mroz, T. and D. Weir, (1990). “Structural Change in Life Cycle Fertility During the Fertility Transition: France Before and After the Revolution of 1789,”. Population Studies, Vol. 44, pp. 61-87, March.

Mroz, T. and D. Weir, (2003) “Stochastic Dynamic Optimization Models with Random Effects in Parameters: An Application to Age at Marriage and Life-cycle Fertility Control in France under the Old Regime,” in History Matters: Essays in Honor of Paul A. David, T. Guinnane, W. Sundstrom, and W. Whatley, eds., Stanford University Press, forthcoming.

Pitt, M., M. Rosenzweig, and D. Gibbons (1993). “The Determinants and Consequences of the Placement of Government Programs in Indonesia,” The World Bank Economic Review 7:319-348.

Rosenzweig, M. and K. Wolpin (1988). "Migration Selectivity and the Effects of Public Programs," Journal of Public Economics 37:265-289.

Schultz, T. (1988). "Heterogeneous Preferences and Migration: Self-Selection, Regional Prices and Programs and the Behavior of Migrants in Colombia," in T.P. Schultz, ed. Research in Population Economics, Volume 6, Greenwich, CT: JAI Press.

Strauss, J. and D. Thomas (1996). "Human Resources: Empirical Modeling Of Household and Family Decisions," in J. Behrman and T. Srinavasan (eds.) Handbook of Development Economics. Amsterdam: North Holland.

Summers, Lawrence H. (1992). "Investing in *All* the People," Policy Research Working Paper 905, May, The World Bank, Washington, D.C.

Thomas, D. (1999). "Fertility, Education, and Resources in South Africa," in Critical Perspectives on Schooling and Fertility in the Developing World, Caroline H. Bledsoe, John B. Casterline, Jennifer A. Johnson-Kuhn, and John G. Haaga, eds, Washington, D.C.: National Academy Press.

The World Bank, (1992). Development Brief, No. 2, (21628), October.

Table 1

Summary Statistics for Models With and Without Endogeneity/Heterogeneity Controls

	Value of the Likelihood Function
Heterogeneity Corrected Model:	-68233.57
Simple Model :	-69469.85
Gain From Heterogeneity Corrections:	1236.28

	Number of Parameters:
Heterogeneity Corrected Model:	349
Simple Model :	259
Increase in Parameters Estimated:	90

Estimated Heterogeneity Distributions*

Point	Community Level Probability Weight	Individual Level Probability Weight
1	0.18607647	0.01473000
2	0.26843781	0.16376214
3	0.29905040	0.58288810
4	0.07178691	0.02805629
5	0.01893237	0.15476934
6	0.02370834	0.03179528
7	0.03258887	0.00938144
8	0.01310505	0.01354703
9	0.02573018	0.00061688
10	0.06058360	0.00045352

* The estimated points of support for the heterogeneity distributions are reported in the tables associated with each of the four outcomes that we model.

Table 2

Logit Estimates for Annual Probability of Conception

Explan. Var.	Heterogeneity Corrected Estimate	Std. Err.	"t-Stat"	Naive Estimates Estimate	Std. Err	"t-Stat"
One	-10.05378	0.6625	-15.175	-6.22751	0.4007	-15.541
ceb (endog)	-0.23107	0.0271	-8.526	-0.03080	0.0126	-2.435
evermar2 (endog)	1.77416	0.1610	11.019	1.45488	0.1483	9.812
Woman's Education Effects (less than primary excluded) (all endogenous)						
primedu	0.13080	0.0646	2.023	-0.01330	0.0445	-0.299
jhighedu	0.15001	0.0861	1.742	-0.07232	0.0551	-1.312
shighedu	0.13120	0.1012	1.296	-0.11531	0.0615	-1.876
univedu	0.32020	0.1141	2.806	0.02904	0.0745	0.390
Husband Education Effects (all endogenous)						
m_hprim	0.20967	0.1320	1.588	0.28565	0.1177	2.427
m_hjhigh	0.43110	0.1446	2.982	0.34749	0.1273	2.729
M_hshigh	0.65248	0.1432	4.557	0.41415	0.1269	3.264
M_huniv	0.78677	0.1522	5.169	0.42860	0.1268	3.381
Family Planning Facility Effects						
Currently Present within 5km						
pusk05	0.07786	0.0456	1.706	0.05325	0.0476	1.119
posy	0.04220	0.0467	0.904	0.05339	0.0431	1.239
priv05	0.02866	0.0465	0.616	0.01434	0.0451	0.318
Duration Family Planning Present in Community (Coefficient on years/(8+years)))						
puskdur8	-0.24671	0.1113	-2.217	0.05463	0.1076	0.508
posydur8	-0.50726	0.1563	-3.245	0.36385	0.1577	-2.307
privdur8	-0.29068	0.1219	-2.385	-0.11663	0.1141	-1.022
Family Planning Available when Woman Aged 7						
pusk05_7	0.07438	0.0589	1.263	-0.02038	0.0703	-0.290
posy_7	0.11878	0.1048	1.133	0.15344	0.1056	1.452
priv05_7	-0.00036	0.0904	-0.004	0.07282	0.0807	0.902
Age Effects (age 10 excluded)						
age11	2.42624	0.5243	4.628	2.30783	0.4601	5.016
age12	2.66768	0.5529	4.825	2.53428	0.4855	5.220
age13	2.93935	0.5508	5.337	2.79739	0.4843	5.776
age14	3.40812	0.5438	6.267	3.17793	0.4803	6.617
age15	3.63340	0.5491	6.617	3.38015	0.4843	6.979
age16	3.96353	0.5452	7.270	3.68155	0.4807	7.658
age17	4.12427	0.5481	7.525	3.80414	0.4848	7.847
age18	4.27760	0.5424	7.887	3.92550	0.4797	8.183
age19	4.37184	0.5463	8.003	3.97956	0.4829	8.241
age20	4.48805	0.5515	8.137	4.03874	0.4887	8.265
age21_22	4.46181	0.5510	8.098	3.94421	0.4880	8.083
age23_24	4.46980	0.5540	8.068	3.85103	0.4895	7.868
age25_26	4.50052	0.5585	8.058	3.77788	0.4930	7.664
age27_28	4.49678	0.5550	8.102	3.67252	0.4884	7.519
age29_30	4.45356	0.5584	7.976	3.53367	0.4903	7.207
age31_35	4.32770	0.5583	7.752	3.26367	0.4890	6.674
age36_40	3.79658	0.5733	6.623	2.57747	0.5053	5.101
age41_45	3.03452	0.5840	5.196	1.72204	0.5127	3.359
age46_49	2.27175	0.7579	2.997	0.86693	0.7068	1.227
Year Effects (Pre 65 excluded)						
yr65_69	0.14012	0.0971	1.444	0.08555	0.0936	0.914
yr70_74	0.14965	0.0990	1.512	0.07478	0.0961	0.778
yr75_79	0.05726	0.0997	0.574	-0.02782	0.0955	-0.291
yr80_84	-0.05031	0.1053	-0.478	-0.15178	0.1049	-1.447
yr85_89	-0.28872	0.1167	-2.474	-0.39299	0.1206	-3.259
yr90_93	-0.61536	0.1343	-4.582	-0.69762	0.1411	-4.944
Other Effects:						
urb	-0.24242	0.2803	-0.865	-0.19132	0.1769	-1.082
evermove	-0.09385	0.0800	-1.173	0.02437	0.0662	0.368
movenum	0.01707	0.0407	0.419	-0.02152	0.0333	-0.647

ineaatt	0.00527	0.0752	0.070	0.00936	0.0597	0.157
mar_yr_d	0.57734	0.0619	9.323	0.74060	0.0588	12.597
lschool	-0.59796	0.1046	-5.716	-0.87422	0.1014	-8.622

Urban-Rural/ Region Effects: (Excluded #25)

unpropd1	0.16321	0.2959	0.552	0.19559	0.1854	1.055
unpropd2	-0.01857	0.2835	-0.066	0.05450	0.1761	0.309
unpropd3	-0.06701	0.4479	-0.150	0.05749	0.1776	0.324
unpropd4	-0.29832	0.2877	-1.037	-0.16272	0.1775	-0.917
unpropd6	-0.21928	0.2756	-0.796	-0.14218	0.1850	-0.768
unpropd7	-0.55785	0.2721	-2.050	-0.36348	0.1760	-2.065
unpropd8	-0.68894	0.2794	-2.466	-0.52083	0.1727	-3.016
unpropd9	-0.51273	0.2777	-1.846	-0.50172	0.1710	-2.935
unpro~10	-0.39543	0.3015	-1.312	-0.26399	0.1739	-1.518
unpro~11	0.33510	0.2861	1.171	0.21717	0.1732	1.254
unpro~12	-0.29628	0.2985	-0.992	-0.24466	0.1815	-1.348
unpro~13	-0.02671	0.2759	-0.097	-0.10838	0.1925	-0.563
unpro~14	0.03059	0.0912	0.335	0.04764	0.0767	0.621
unpro~15	0.15265	0.1117	1.367	0.16549	0.0952	1.738
unpro~16	0.14171	0.1577	0.899	0.18769	0.1003	1.870
unpro~17	0.17641	0.1611	1.095	0.19037	0.1576	1.208
unpro~19	-0.18917	0.0884	-2.139	-0.08613	0.0706	-1.221
unpro~20	-0.23560	0.0881	-2.673	-0.14243	0.0831	-1.714
unpro~21	-0.38251	0.2224	-1.720	-0.25371	0.1629	-1.557
unpro~22	-0.32269	0.0820	-3.935	-0.38695	0.0670	-5.774
unpro~23	-0.31629	0.0928	-3.410	-0.25154	0.0968	-2.600
unpro~24	0.37505	0.1119	3.350	0.39595	0.1127	3.514
unpro~26	0.18786	0.1223	1.536	0.15066	0.1034	1.458

Unobserved Heterogeneity Effects:

Cluster Level

OMEGAcl	0.0	-- NORMALIZED AT ZERO	
OMEGAcl	-0.17775	0.0627	-2.836
OMEGAcl	0.15628	0.0498	3.140
OMEGAcl	0.57211	0.0628	9.104
OMEGAcl	0.24844	0.1036	2.399
OMEGAcl	0.25085	0.0900	2.787
OMEGAcl	-0.13714	0.0904	-1.517
OMEGAcl	-0.45540	0.1212	-3.758
OMEGAcl	-0.43844	0.1146	-3.827
OMEGAcl	0.49339	0.0747	6.602

Individual Level

OMEGAi	0.0	-- NORMALIZED AT ZERO	
OMEGAi	2.65407	0.6033	4.400
OMEGAi	3.08065	0.6041	5.100
OMEGAi	4.84999	0.6708	7.230
OMEGAi	3.82054	0.6713	5.691
OMEGAi	3.09732	0.6559	4.722
OMEGAi	1.22830	0.9031	1.360
OMEGAi	0.30722	6.2105	0.049
OMEGAi	-0.09052	0.6942	-0.130
OMEGAi	-0.06514	0.5800	-0.112

Table 3A

Simulation Results from the Heterogeneity Corrected Estimates

	Women's Education	Proportion Married	Age at Marriage	Husband's Education	Children Ever Born
No Family Planning Facilities					
Poor schools	4.42	0.954	19.97	5.34	4.89
Good Schools	4.68	0.954	20.02	5.52	4.89
Complete Family Planning Facilities					
Poor Schools	5.21	0.936	20.91	6.33	3.87
Good Schools	5.45	0.935	20.97	6.51	3.88

Table 3B

Simulation Results from the Model with No Heterogeneity and No Endogeneity Controls

	Women's Education	Proportion Married	Age at Marriage	Husband's Education	Children Ever Born
No Family Planning Programs					
Poor schools	4.65	0.973	19.72	5.06	5.15
Good Schools	4.96	0.971	19.83	5.31	5.13
Complete Family Planning Programs					
Poor Schools	5.92	0.960	20.42	5.91	5.02
Good Schools	6.20	0.960	20.51	6.11	5.01

Table 4

Simulated Completed Family Sizes as a Function of Exogenously Assigned Schooling Levels
(School quality at 1970 levels)

	Model with Heterogeneity and Endogeneity Controls		Model without Heterogeneity and Endogeneity Controls	
Assigned Education Level	No Family Planning Services	Full Set of Family Planning Services	No Family Planning Services	Full Set of Family Planning Services
No Schooling	4.94	3.93	5.30	5.27
Completed Primary	4.86	3.87	5.11	5.08
Junior High School	4.76	3.78	4.86	4.82
Senior High School	4.59	3.62	4.42	4.39
Some University	5.24	4.16	4.36	4.36

Appendix Table 1

A. Summary Statistics. Fertility Equation
N = 113,995 (person-years at risk of conception)

Variable	Mean	Std. Dev.
concenew	0.1341	0.3407
cebn	1.7110	2.1190
evermar2	0.6134	0.4870
primedu	0.5443	0.4980
jhighedu	0.1384	0.3454
shighedu	0.0935	0.2911
univedu	0.0312	0.1740
m_hprim	0.3771	0.4847
m_hjhigh	0.1002	0.3003
m_hshigh	0.0827	0.2754
m_huniv	0.0363	0.1869
pusk05	0.5969	0.4602
posy	0.4200	0.4733
priv05	0.4848	0.4697
puskdur8	0.2624	0.2722
posydur8	0.1475	0.2155
privdur8	0.1947	0.2513
pusk05_7	0.0604	0.2383
posy_7	0.0110	0.1043
priv05_7	0.0368	0.1883
age11	0.0409	0.1980
age12	0.0409	0.1980
age13	0.0409	0.1980
age14	0.0409	0.1980
age15	0.0409	0.1980
age16	0.0408	0.1979
age17	0.0408	0.1977
age18	0.0406	0.1974
age19	0.0403	0.1967
age20	0.0400	0.1959
age21_22	0.0777	0.2677
age23_24	0.0741	0.2619
age25_26	0.0691	0.2537
age27_28	0.0630	0.2429
age29_30	0.0567	0.2312
age31_35	0.1085	0.3110
age36_40	0.0662	0.2486
age41_45	0.0303	0.1713
age46_49	0.0069	0.0825
yr65_69	0.0824	0.2750
yr70_74	0.1266	0.3325
yr75_79	0.1686	0.3744
yr80_84	0.1955	0.3966
yr85_89	0.2039	0.4029
yr90_93	0.1635	0.3698
urb	0.4232	0.4941

evermove	0.3168	0.4652
movenum	0.2165	0.6107
ineaatt	0.7623	0.4257
mar_yr_d	0.0387	0.1929
lschool	0.1572	0.3640
unprp2	0.0319	0.1757
unprp3	0.0296	0.1694
unprp4	0.0347	0.1830
unprp5	0.0005	0.0233
unprp6	0.0845	0.2782
unprp7	0.0829	0.2758
unprp8	0.0319	0.1759
unprp9	0.0975	0.2967
unprp10	0.0296	0.1695
unprp11	0.0376	0.1902
unprp12	0.0315	0.1746
unprp13	0.0386	0.1927
unprp14	0.0390	0.1935
unprp15	0.0199	0.1397
unprp16	0.0204	0.1413
unprp17	0.0067	0.0815
unprp18	0.1071	0.3093
unprp19	0.0608	0.2390
unprp20	0.0402	0.1965
unprp21	0.0157	0.1242
unprp22	0.0477	0.2131
unprp23	0.0224	0.1481
unprp24	0.0170	0.1293
unprp25	0.0129	0.1129
unprp26	0.0134	0.1148

Appendix Table 1 (continued)

B. Summary Statistics. School Attendance Equation
N = 33,306 (person-years at risk of leaving school)

Variable	Mean	Std. Dev.
inschnew	0.8509	0.3562
age7	0.1508	0.3579
age8	0.1253	0.3311
age9	0.1192	0.3240
age10	0.1088	0.3114
age11	0.0988	0.2985
age12	0.0892	0.2850
age13	0.0814	0.2734
age14	0.0508	0.2197
age15	0.0432	0.2033
age16	0.0390	0.1937
age17	0.0282	0.1654
age18	0.0236	0.1518
age19	0.0220	0.1466
age20	0.0076	0.0870
yr65_69	0.1697	0.3754

yr70_74	0.1922	0.3940
yr75_79	0.1778	0.3824
yr80_84	0.1428	0.3499
yr85_89	0.0800	0.2713
yr90_93	0.0221	0.1469
stratpf	3.4371	0.7503
stratsf	1.5508	0.2285
ssratpf	2.2766	0.4755
ssratsf	2.6820	0.7910
pusk05	0.3403	0.4349
posy	0.1632	0.3425
priv05	0.2514	0.3958
puskdur8	0.1161	0.2052
posydur8	0.0427	0.1247
privdur8	0.0786	0.1747
pusk05_7	0.1362	0.3430
posy_7	0.0383	0.1920
priv05_7	0.0986	0.2981
urb	0.5128	0.4998
evermove	0.3498	0.4769
movenum	0.0466	0.2419
ineaatt	0.6590	0.4741
unprp2	0.0321	0.1763
unprp3	0.0273	0.1629
unprp4	0.0243	0.1539
unprp5	0.0006	0.0251
unprp6	0.0653	0.2471
unprp7	0.0645	0.2456
unprp8	0.0409	0.1981
unprp9	0.0818	0.2740
unprp10	0.0207	0.1424
unprp11	0.0288	0.1673
unprp12	0.0280	0.1651
unprp13	0.0291	0.1682
unprp14	0.0515	0.2209
unprp15	0.0283	0.1660
unprp16	0.0268	0.1615
unprp17	0.0071	0.0839
unprp18	0.1313	0.3377
unprp19	0.0763	0.2655
unprp20	0.0439	0.2049
unprp21	0.0258	0.1585
unprp22	0.0509	0.2197
unprp23	0.0244	0.1541
unprp24	0.0165	0.1274
unprp25	0.0126	0.1113
unprp26	0.0175	0.1313

Appendix Table 1 (continued)

C. Summary Statistics. First Marriage Equation

N = 51,087 (person-years at risk of entering marriage)

Variable	Mean	Std. Dev.
married1new	0.0988	0.2983
age15	0.0831	0.2760
age16	0.0746	0.2628
age17	0.0660	0.2484
age18	0.0553	0.2286
age19	0.0450	0.2073
age20	0.0374	0.1898
age21_22	0.0520	0.2220
age23_24	0.0331	0.1790
age25_26	0.0209	0.1429
age27_28	0.0135	0.1156
age29_30	0.0101	0.1001
yr65_69	0.1377	0.3446
yr70_74	0.1784	0.3829
yr75_79	0.1961	0.3970
yr80_84	0.1783	0.3828
yr85_89	0.1307	0.3371
yr90_93	0.0601	0.2376
primedu	0.5511	0.4974
jhighedu	0.1598	0.3664
shighedu	0.1027	0.3036
univedu	0.0312	0.1738
pusk05	0.4546	0.4613
posy	0.2563	0.4110
priv05	0.3409	0.4377
puskdur8	0.1717	0.2393
posydur8	0.0771	0.1655
privdur8	0.1191	0.2098
pusk05_7	0.1035	0.3046
posy_7	0.0255	0.1577
priv05_7	0.0687	0.2530
urb	0.4609	0.4985
evermove	0.3287	0.4697
movenum	0.1087	0.4072
ineaatt	0.7008	0.4579
lschool	0.3868	0.4870
unprp2	0.0312	0.1739
unprp3	0.0284	0.1662
unprp4	0.0270	0.1620
unprp5	0.0005	0.0212
unprp6	0.0696	0.2545
unprp7	0.0714	0.2575
unprp8	0.0362	0.1868
unprp9	0.0939	0.2917
unprp10	0.0302	0.1712
unprp11	0.0375	0.1900
unprp12	0.0300	0.1706
unprp13	0.0374	0.1897
unprp14	0.0498	0.2174
unprp15	0.0221	0.1471

unprp16	0.0224	0.1481
unprp17	0.0069	0.0827
unprp18	0.1158	0.3200
unprp19	0.0650	0.2465
unprp20	0.0395	0.1949
unprp21	0.0199	0.1396
unprp22	0.0490	0.2159
unprp23	0.0253	0.1569
unprp24	0.0186	0.1351
unprp25	0.0118	0.1078
unprp26	0.0148	0.1209

Appendix Table 1 (continued)

D. Summary Statistics. Husband's School Attendance Equation
N = 37,193 (person-years at risk of leaving school)

Variable	Mean	Std. Dev.
husinschne	0.8754	0.3302
age7	0.1252	0.3310
age8	0.1233	0.3288
age9	0.1179	0.3225
age10	0.1088	0.3113
age11	0.0995	0.2994
age12	0.0909	0.2875
age13	0.0849	0.2788
age14	0.0503	0.2185
age15	0.0431	0.2031
age16	0.0395	0.1948
age17	0.0289	0.1675
age18	0.0270	0.1620
age19	0.0260	0.1591
age20	0.0083	0.0905
yr65_69	0.1841	0.3876
yr70_74	0.2115	0.4084
yr75_79	0.1837	0.3873
yr80_84	0.1223	0.3276
yr85_89	0.0506	0.2192
yr90_93	0.0101	0.0998
prim	0.4283	0.4948
jhigh	0.1665	0.3725
shigh	0.2002	0.4002
univ	0.0814	0.2735
stratpf	3.5146	0.7356
stratsf	1.5546	0.2240
ssratpf	2.2832	0.4773
ssratsf	2.5862	0.7541
pusk05	0.2920	0.4159
posy	0.1175	0.2945
priv05	0.2075	0.3690
puskdur8	0.0892	0.1788
posydur8	0.0278	0.1002

privdur8	0.0584	0.1494
pusk05_7	0.0980	0.2973
posy_7	0.0190	0.1366
priv05_7	0.0654	0.2472
urb	0.4878	0.4999
evermove	0.3418	0.4743
movenum	0.0530	0.2721
ineaatt	0.6686	0.4707
unprp2	0.0267	0.1611
unprp3	0.0275	0.1636
unprp4	0.0263	0.1601
unprp5	0.0006	0.0243
unprp6	0.0729	0.2600
unprp7	0.0675	0.2509
unprp8	0.0359	0.1860
unprp9	0.0860	0.2803
unprp10	0.0294	0.1688
unprp11	0.0337	0.1806
unprp12	0.0321	0.1763
unprp13	0.0311	0.1736
unprp14	0.0451	0.2074
unprp15	0.0226	0.1485
unprp16	0.0248	0.1555
unprp17	0.0067	0.0819
unprp18	0.1302	0.3365
unprp19	0.0731	0.2603
unprp20	0.0425	0.2018
unprp21	0.0173	0.1305
unprp22	0.0511	0.2201
unprp23	0.0268	0.1614
unprp24	0.0178	0.1323
unprp25	0.0138	0.1169
unprp26	0.0160	0.1254

Appendix Table 2

Description of Variables

Conce	Dummy, a conception leading to a live birth occurred
Inschool	Dummy, woman is attending school
Firstmar	Dummy, woman got married for first time
ceb	Children ever born
evermar2	Dummy, woman is married
primedu	Dummy, years of schooling are between 1 and 6
jhighedu	Dummy, years of schooling are between 7 and 9
shghedu	Dummy, years of schooling are between 10 and 12
univedu	Dummy, years of schooling are 13 or over
m_hprim	Dummy, husband's years of schooling are between 1 and 6
m_hjhigh	Dummy, husband's years of schooling are between 7 and 9
m_hshigh	Dummy, husband's years of schooling are between 10 and 12
m_huniv	Dummy, husband's years of schooling are 13 or over
pusk05	Dummy, *Puskesmas* with FP services available within 5 kms.
posy	Dummy, *Posyandu* with FP services available in the villlage
priv05	Dummy, Private provider with FP services available within 5 kms.
puskdur8	Transformation of number of years *Puskesmas* has been offering FP, (years/(8+years))
posydur8	Transformation of number of years *Posyandu* has been offering FP, (years/(8+years))
privdur8	Transformation of number of years Private provider has been offering FP, (years/(8+years))
pusk05_7	Dummy, *Puskesmas* with FP services available when woman was age 7
posy_7	Dummy, *Posyandu* with FP services available when woman was age 7
priv05_7	Dummy, Private provider with FP services available when woman was age 7
age*	Dummy, woman is age *, where * is a single years between 7 and 20
age21_22	Dummy, woman is age 21-22
age23_24	Dummy, woman is age 23-24
age25_26	Dummy, woman is age 25-26
age27_28	Dummy, woman is age 27-28
age29_30	Dummy, woman is age 29-30
age31_35	Dummy, woman is age 31-35
age36_40	Dummy, woman is age 36-40
age41_45	Dummy, woman is age 41-45
age46_49	Dummy, woman is age 46-49
yr65_69	Dummy, calendar year is between 1965-1969
yr70_74	Dummy, calendar year is between 1970-1974
yr75_79	Dummy, calendar year is between 1975-1979
yr80_84	Dummy, calendar year is between 1980-1984
yr85_89	Dummy, calendar year is between 1985-1989
yr90_93	Dummy, calendar year is between 1990-1993
urb	Dummy, place of residence is urban
evermove	Dummy, changed region of residence at least once since age 7

movenum	Number of change of residence
ineaatt	Dummy, living in 1993 IFLS enumeration area this year
mar_yr_d	Dummy, first marriage this year
lschool	Dummy, attending school
unpropd*	Dummy, region of residence (13 IFLS provinces times 2 area categories (urban-rural), for 26 categories), where: * = 1, ..., 26; 25 excluded
stratpf	Student-teacher ratio, primary school, by region, divided by 10
stratsf	Student-teacher ratio, secondary school, by region, divided by 10
ssratpf	Student-school ratio, primary school, by region, divided by 100
ssratsf	Student-school ratio, secondary school, by region, divided by 100

Appendix Table 3

Logit Estimates for Annual Continuation of Schooling

	Heterogeneity Corrected (Scale adjustment for heterogeneity estimates: 0.743)			Naive Estimates		
Explan. Var.	Estimate	Std. Err.	"t-Stat"	Estimate	Std. Err.	"t-Stat"
One	-5.94172	1.5313	-3.880	-0.63918	0.5007	-1.2777
Age Effects (age 6 excluded)						
age7	6.26348	0.3864	16.208	2.09481	0.1562	13.411
age8	7.33286	0.3736	19.628	3.38415	0.1630	20.766
age9	6.47592	0.3548	18.252	2.78507	0.1537	18.122
age10	6.10287	0.3333	18.311	2.63775	0.1429	18.455
age11	5.72855	0.3302	17.347	2.47752	0.1368	18.107
age12	5.68231	0.3332	17.052	2.60895	0.1569	16.628
age13	2.84908	0.2817	10.113	0.36974	0.1386	2.668
age14	3.73725	0.2706	13.812	1.49627	0.1457	10.268
age15	4.28133	0.2831	15.123	2.22906	0.1656	13.462
age16	2.61439	0.2392	10.928	0.87404	0.1385	6.309
age17	3.02669	0.2215	13.663	1.46670	0.1411	10.393
age18	3.77781	0.2771	13.633	2.34379	0.2167	10.817
age19	-0.15896	0.1670	-0.952	-0.99732	0.1304	-7.650
age20	0.51735	0.2115	2.446	0.11322	0.2001	0.566
Year Effects (Pre 1965 excluded)						
yr65_69	0.26032	0.0985	2.642	0.23467	0.0797	2.945
yr70_74	0.19240	0.1482	1.298	0.13199	0.1192	1.107
yr75_79	0.58608	0.1699	3.450	0.34769	0.1341	2.594
yr80_84	0.96302	0.2457	3.920	0.53681	0.2047	2.623
yr85_89	1.12676	0.2941	3.832	0.48376	0.2393	2.022
yr90_93	0.60191	0.3405	1.768	-0.04837	0.2912	-0.166
School Quality Effects (primary and secondary school student-teacher ratios and students per school ratios)						
stratpf	-0.10534	0.1281	-0.823	-0.09773	0.0952	-1.027
stratsf	-0.43257	0.2607	-1.659	-0.25041	0.2104	-1.190
ssratpf	0.14664	0.2353	0.623	0.19848	0.1654	1.200
ssratsf	0.33475	0.1270	2.636	0.14466	0.1024	1.413
Family Planning Facility Effects						
Currently Present within 5km						
pusk05	0.02882	0.1227	0.235	-0.03249	0.1064	-0.305
posy	0.30410	0.1650	1.843	0.16462	0.1240	1.328
priv05	0.05642	0.1425	0.396	0.01546	0.1114	0.139
Duration Family Planning Present in Community (Coefficient on years/(8+years))						
puskdur8	0.16903	0.4127	0.410	0.41146	0.3017	1.364
posydur8	-0.29452	0.5021	-0.587	-0.04617	0.3930	-0.117
privdur8	-0.55119	0.4278	-1.288	-0.40052	0.2655	-1.508
Family Planning Available when Woman Aged 7						
pusk05_7	0.07744	0.1352	0.573	-0.03691	0.1097	-0.337
posy_7	0.22979	0.2427	0.947	0.09173	0.1563	0.587
priv05_7	0.40049	0.1818	2.202	0.35309	0.1033	3.418
Other Effects						
urb	0.55067	0.9636	0.571	0.55860	0.1524	3.665
evermove	0.36658	0.4748	0.772	0.14017	0.3141	0.446
movenum	-0.04324	0.1443	-0.300	-0.07742	0.1075	-0.720
ineaatt	-0.01837	0.4599	-0.040	-0.26635	0.3025	-0.880
Urban-Rural/ Region Effects: (Excluded #25)						
unpropd1	0.30568	1.0364	0.295	0.25441	0.2420	1.051
unpropd2	0.29145	1.0790	0.270	0.26508	0.2647	1.001
unpropd3	0.34304	1.3489	0.254	0.10134	0.3047	0.333
unpropd4	-0.19844	0.9980	-0.199	-0.36230	0.2185	-1.658
unpropd6	0.45593	1.0491	0.435	-0.37242	0.2191	-1.700
unpropd7	0.88684	1.0711	0.828	-0.11351	0.2419	-0.469
unpropd8	0.78323	1.0628	0.737	0.54151	0.2004	2.702

unpropd9	0.01549	1.0195	0.015	-0.19973	0.2159	-0.925
unpro~10	-0.38568	1.1996	-0.321	-0.38340	0.2500	-1.534
unpro~11	-1.09426	1.0511	-1.041	-0.25899	0.2478	-1.045
unpro~12	-0.13707	1.0707	-0.128	-0.16858	0.2496	-0.676
unpro~13	-0.36798	1.0424	-0.353	-0.28379	0.2783	-1.020
unpro~14	0.12349	0.3186	0.388	0.12281	0.2144	0.573
unpro~15	0.47465	0.3357	1.414	0.40529	0.2197	1.845
unpro~16	0.61307	0.9885	0.620	0.38722	0.2236	1.732
unpro~17	1.08857	0.4731	2.301	-0.02250	0.3641	-0.062
unpro~19	-0.09645	0.3805	-0.254	0.16261	0.2444	0.665
unpro~20	0.20744	0.3520	0.589	0.03971	0.2440	0.163
unpro~21	0.35022	0.5363	0.653	0.38036	0.2886	1.318
unpro~22	-0.23125	0.3047	-0.759	-0.02782	0.2215	-0.126
unpro~23	-0.02721	0.5683	-0.048	-0.05247	0.2943	-0.178
unpro~24	-1.02331	0.4206	-2.433	-0.63094	0.3665	-1.721
unpro~26	0.26820	0.3630	0.739	0.18085	0.2853	0.634

Unobserved Heterogeneity Effects

Cluster Level

OMEGAcl	0.0	--	NORMALIZED AT ZERO
OMEGAcl	2.09924	0.1452	14.462
OMEGAcl	0.87448	0.1236	7.073
OMEGAcl	-1.07300	0.2018	-5.317
OMEGAcl	-2.77245	0.3450	-8.037
OMEGAcl	-0.91919	0.1972	-4.661
OMEGAcl	-1.27237	0.1387	-9.174
OMEGAcl	-0.29871	0.1465	-2.039
OMEGAcl	0.76667	0.1704	4.499
OMEGAcl	0.01339	0.1687	0.079

Individual Level

OMEGAi	0.0	--	NORMALIZED AT ZERO
OMEGAi	2.92273	0.3386	8.633
OMEGAi	0.80540	0.3086	2.610
OMEGAi	0.79975	0.5924	1.350
OMEGAi	-0.43640	0.4420	-0.987
OMEGAi	-1.43928	0.6264	-2.298
OMEGAi	-1.51762	0.8877	-1.710
OMEGAi	0.25778	0.5827	0.442
OMEGAi	0.02156	0.0628	0.344
OMEGAi	0.26312	0.1414	1.861

Appendix Table 4

Logit Estimates for Annual Hazard of First Marriage

	Heterogeneity Corrected (Scale adjustment for heterogeneity estimates: 0.925)			Naive Estimates		
Explan. Var.	Estimate	Std. Err.	"t-Stat"	Estimate	Std. Err.	"t-Stat"
one	-3.67802	1.0334	-3.559	-2.24243	0.7521	-2.982
Age Effects (10-14, excluded)						
age15	0.81168	0.0737	11.013	0.78419	0.0738	10.623
age16	0.96448	0.0793	12.163	0.90970	0.0762	11.936
age17	1.43643	0.0756	19.008	1.34067	0.0695	19.282
age18	1.60915	0.0857	18.781	1.47751	0.0842	17.538
age19	1.49692	0.0945	15.848	1.33377	0.0907	14.708
age20	1.71798	0.0929	18.483	1.51212	0.0879	17.208
age21_22	1.61653	0.0993	16.279	1.36842	0.0886	15.450
age23_24	1.59300	0.1160	13.737	1.29133	0.1009	12.804
age25_26	1.58488	0.1259	12.588	1.24064	0.1083	11.457
age27_28	1.26017	0.1594	7.906	0.89061	0.1500	5.936
age29_30	0.97892	0.1740	5.626	0.55997	0.1626	3.443
Year Effects (Pre 65 excluded)						
yr65_69	-0.08852	0.0933	-0.949	-0.13187	0.0928	-1.420
yr70_74	-0.17503	0.0863	-2.028	-0.24119	0.0876	-2.754
yr75_79	-0.24520	0.0885	-2.769	-0.26951	0.0925	-2.914
yr80_84	-0.20855	0.1072	-1.946	-0.18177	0.1147	-1.585
yr85_89	-0.14807	0.1239	-1.195	-0.10950	0.1343	-0.815
yr90_93	-0.22331	0.1697	-1.316	-0.22171	0.1894	-1.171
Education Effects						
primedu	0.25433	0.0750	3.392	0.14487	0.0605	2.393
jhighedu	0.29568	0.1077	2.745	0.10129	0.0827	1.225
shighedu	0.33826	0.1197	2.827	0.10579	0.0859	1.231
univedu	0.39780	0.1889	2.106	0.11004	0.1547	0.711
Family Planning Facility Effects						
Currently Present within 5km						
pusk05	-0.11634	0.0810	-1.436	-0.07070	0.0825	-0.857
posy	0.12330	0.0950	1.298	0.12433	0.0920	1.351
priv05	0.05759	0.0865	0.666	0.01794	0.0890	0.202
Duration Family Planning Present in Community (Coefficient on years/(8+years))						
puskdur8	0.16242	0.1653	0.982	0.09054	0.1589	0.570
posydur8	-0.51462	0.2662	-1.933	-0.50818	0.2240	-2.269
privdur8	0.06979	0.2111	0.331	0.02207	0.2022	0.109
Family Planning Available when Woman Aged 7						
pusk05_7	-0.08520	0.0768	-1.109	-0.02123	0.0786	-0.270
posy_7	-0.01592	0.1733	-0.092	0.10821	0.1667	0.649
priv05_7	0.06431	0.1151	0.559	0.07725	0.1144	0.675
Other Effects						
urb	-0.64586	0.8209	-0.787	-0.66817	0.7418	-0.901
evermove	-0.11324	0.1536	-0.737	-0.02390	0.1484	-0.161
movenum	0.37098	0.0711	5.217	0.28710	0.0674	4.261
ineaatt	0.18409	0.1368	1.345	0.16443	0.1374	1.197
lschool	-1.35269	0.0796	-17.002	-1.48074	0.0770	-19.241
Urban-Rural/ Region Effects: (Excluded #25)						
unpropd1	-0.71322	0.8364	-0.853	-0.69241	0.7505	-0.923
unpropd2	-0.78479	0.8365	-0.938	-0.76295	0.7564	-1.009
unpropd3	-0.38450	0.8742	-0.440	-0.43316	0.7540	-0.574
unpropd4	-0.14439	0.8283	-0.174	-0.20457	0.7463	-0.274
unpropd6	-0.08738	0.8247	-0.106	-0.08234	0.7498	-0.110
unpropd7	-0.41677	0.8160	-0.511	-0.35437	0.7478	-0.474
unpropd8	-0.79495	0.8486	-0.937	-0.82981	0.7489	-1.108
unpropd9	-0.23044	0.8313	-0.277	-0.36740	0.7449	-0.493
unpro~10	-0.70974	0.8373	-0.848	-0.72795	0.7552	-0.964
unpro~11	-0.25484	0.8302	-0.307	-0.43649	0.7515	-0.581
unpro~12	-0.19176	0.8368	-0.229	-0.29782	0.7528	-0.396
unpro~13	-0.68305	0.8498	-0.804	-0.75836	0.7670	-0.989
unpro~14	-0.49404	0.1450	-3.406	-0.51810	0.1305	-3.971

unpro~15	0.12557	0.1562	0.804	0.09530	0.1287	0.740
unpro~16	-0.20103	0.2651	-0.758	-0.20471	0.1911	-1.071
unpro~17	0.13830	0.2598	0.532	0.09344	0.2285	0.409
unpro~19	0.18802	0.1088	1.727	0.15959	0.1090	1.464
unpro~20	-0.01081	0.1139	-0.095	0.15937	0.1061	1.501
unpro~21	-0.16161	0.2648	-0.610	-0.25404	0.1697	-1.497
unpro~22	0.11951	0.1166	1.025	-0.01281	0.1081	-0.118
unpro~23	-0.17580	0.1837	-0.957	-0.19627	0.1506	-1.304
unpro~24	0.14252	0.2278	0.626	0.01111	0.1737	0.064
unpro~26	0.26427	0.1700	1.554	0.16904	0.1515	1.116

Unobserved Heterogeneity Effects

Cluster Level Effects

OMEGAcl	0.0	--	NORMALIZED AT ZERO
OMEGAcl	-0.27151	0.1023	-2.653
OMEGAcl	-0.16091	0.0980	-1.642
OMEGAcl	0.17841	0.1024	1.742
OMEGAcl	0.42727	0.2033	2.102
OMEGAcl	0.76913	0.1313	5.858
OMEGAcl	0.09558	0.1027	0.930
OMEGAcl	0.42384	0.0933	4.545
OMEGAcl	-0.34792	0.2982	-1.167
OMEGAcl	0.39533	0.1229	3.217

Individual Level Effects

OMEGAi	0.0	--	NORMALIZED AT ZERO
OMEGAi	0.91027	0.8796	1.035
OMEGAi	1.21376	0.8652	1.403
OMEGAi	1.93447	0.8969	2.157
OMEGAi	1.61399	0.9028	1.788
OMEGAi	0.45099	1.2377	0.364
OMEGAi	1.67528	1.4983	1.118
OMEGAi	-3.53177	11.9690	-0.295
OMEGAi	0.05657	0.1778	0.318
OMEGAi	0.27604	0.6190	0.446

Appendix Table 5

Logit Estimates for the Schooling of the Women's Husband

	Heterogeneity Corrected			Naive Estimates		
Explan. Var.	Estimate	Std. Err.	"t-Stat"	Estimate	Std. Err.	"t-Stat"
one	-2.91202	1.8820	-1.547	-1.45711	0.9269	-1.572
Age Effects						
age7	7.98401	0.5379	14.843	4.58934	0.3254	14.102
age8	6.66597	0.4353	15.314	3.67976	0.2983	12.337
age9	5.72736	0.4264	13.431	3.05338	0.3023	10.099
age10	5.32731	0.4203	12.675	2.85731	0.3096	9.229
age11	5.21368	0.4021	12.966	2.89619	0.3056	9.477
age12	5.35655	0.3988	13.432	3.17546	0.3085	10.292
age13	2.03909	0.3504	5.820	0.35002	0.2810	1.246
age14	3.10421	0.3457	8.980	1.62661	0.2885	5.639
age15	3.64571	0.3356	10.865	2.32704	0.2821	8.249
age16	1.74734	0.2981	5.862	0.66377	0.2661	2.494
age17	3.41756	0.3139	10.888	2.47773	0.2943	8.419
age18	3.73514	0.3234	11.548	2.85899	0.3159	9.051
age19	-1.34566	0.2163	-6.221	-1.90269	0.2173	-8.756
age20	0.94880	0.2545	3.729	0.70183	0.2676	2.623
Year Effects (Pre 65 excluded)						
yr65_69	0.12107	0.0990	1.223	0.03334	0.0728	0.458
yr70_74	-0.01647	0.1569	-0.105	-0.07058	0.1200	-0.588
yr75_79	-0.13094	0.1809	-0.724	-0.27029	0.1428	-1.893
yr80_84	0.02527	0.2321	0.109	-0.26297	0.1799	-1.462
yr85_89	0.10788	0.3172	0.340	-0.33991	0.2473	-1.374
yr90_93	0.14215	0.4292	0.331	-0.44049	0.3445	-1.279
Woman's Education Effects						
prim	-0.70244	0.1345	-5.223	0.34084	0.0609	5.601
jhigh	-0.16837	0.1713	-0.983	1.28986	0.0766	16.836
shigh	0.43041	0.2080	2.069	2.34092	0.1026	22.808
univ	0.17202	0.2911	0.591	2.70348	0.1419	19.054
School Quality Effects (primary and secondary student-teacher ratios)						
stratpf	-0.04222	0.1204	-0.351	-0.01126	0.0931	-0.121
stratsf	-0.33268	0.2849	-1.168	-0.24565	0.2380	-1.032
ssratpf	0.07299	0.2140	0.341	0.09338	0.1612	0.579
ssratsf	0.33698	0.1282	2.630	0.17474	0.1107	1.578
Family Planning Facility Effects						
Currently Present within 5km						
pusk05	0.16327	0.1034	1.578	0.09423	0.1015	0.928
posy	-0.05954	0.1398	-0.426	-0.13835	0.1276	-1.084
priv05	-0.04092	0.1145	-0.357	-0.00799	0.0930	-0.086
Duration Family Planning Present in Community (Coefficient on years/(8+years))						
puskdur8	-0.25612	0.3219	-0.796	-0.11413	0.3186	-0.358
posydur8	0.38401	0.4950	0.776	0.14790	0.4327	0.342
privdur8	0.39275	0.4327	0.908	0.33755	0.3188	1.059
Family Planning Available when Woman Aged 7						
pusk05_7	0.10287	0.1337	0.769	-0.00438	0.1252	-0.035
posy_7	0.30023	0.3201	0.938	0.25326	0.2221	1.140
priv05_7	0.19044	0.2027	0.940	0.06270	0.1440	0.435
Other Effects						
urb	0.44693	1.4936	0.299	0.30265	0.6490	0.466
evermove	0.37960	0.3507	1.082	0.27412	0.2932	0.935
movenum	0.04634	0.1327	0.349	0.02104	0.0989	0.213
ineaatt	0.07476	0.3306	0.226	0.10953	0.2879	0.380
Urban-Rural/ Regional Effects: (Excluded #25)						
unpropd1	-0.08016	1.5008	-0.053	0.03685	0.6645	0.055
unpropd2	-0.47596	1.5378	-0.310	-0.28689	0.6941	-0.413
unpropd3	0.17743	1.6124	0.110	0.08450	0.6773	0.125
unpropd4	-0.59254	1.5124	-0.392	-0.35249	0.6797	-0.519

unpropd6	0.22568	1.5254	0.148	-0.12429	0.6727	-0.185
unpropd7	0.46831	1.5496	0.302	-0.10204	0.6772	-0.151
unpropd8	0.42425	1.5426	0.275	0.23946	0.6940	0.345
unpropd9	-0.22289	1.5086	-0.148	-0.09434	0.6647	-0.142
unpro~10	0.35661	1.6312	0.219	0.35219	0.6867	0.513
unpro~11	-0.84091	1.5030	-0.559	0.09984	0.6880	0.145
unpro~12	0.08520	1.5436	0.055	0.17815	0.7005	0.254
unpro~13	-0.35258	1.5126	-0.233	-0.13990	0.6810	-0.205
unpro~14	0.02926	0.2748	0.106	0.07787	0.1612	0.483
unpro~15	-0.42230	0.2828	-1.494	-0.28927	0.1971	-1.468
unpro~16	0.47402	0.7442	0.637	0.31316	0.1890	1.657
unpro~17	0.30421	0.3257	0.934	-0.13531	0.2049	-0.661
unpro~19	-0.12545	0.3122	-0.402	0.01196	0.1915	0.062
unpro~20	-0.08435	0.3212	-0.263	-0.14513	0.2185	-0.664
unpro~21	-0.20261	0.3694	-0.548	-0.13572	0.1796	-0.756
unpro~22	-0.24781	0.2430	-1.020	-0.05005	0.1624	-0.308
unpro~23	0.24212	0.5136	0.471	0.20562	0.2420	0.850
unpro~24	-0.56988	0.3629	-1.570	-0.03091	0.2983	-0.104
unpro~26	-0.06384	0.3363	-0.190	-0.10013	0.2064	-0.485

Observed Heterogeneity Effects

Cluster Level

OMEGAcl	0.0	--	NORMALIZED AT ZERO
OMEGAcl	1.71938	0.1762	9.758
OMEGAcl	0.91795	0.1305	7.036
OMEGAcl	-0.76472	0.1727	-4.429
OMEGAcl	-0.64806	0.1532	-4.229
OMEGAcl	-0.81324	0.2138	-3.803
OMEGAcl	-1.00478	0.1929	-5.209
OMEGAcl	-0.13971	0.1661	-0.841
OMEGAcl	0.29581	0.1820	1.626
OMEGAcl	0.40300	0.2999	1.344

Individual Level

OMEGAi	0.0	--	NORMALIZED AT ZERO
OMEGAi	1.75662	0.5680	3.093
OMEGAi	-0.36048	0.5243	-0.688
OMEGAi	-0.09189	0.8370	-0.110
OMEGAi	-1.75476	0.7411	-2.368
OMEGAi	-4.57759	1.9969	-2.292
OMEGAi	-2.89899	0.7430	-3.902
OMEGAi	-0.39587	3.1453	-0.126
OMEGAi	0.02718	0.0676	0.402
OMEGAi	0.22714	0.6113	0.372

Appendix Table 6

Parameters Defining the Unobserved Heterogeneity Distributions

Community Probability Weights (Multivariate Logit Transform)

	Coefficient	Std. Err.	T-Score
PROBWTcl	0.36646	0.3051	1.201
PROBWTcl	0.47445	0.3478	1.364
PROBWTcl	-0.95246	0.4053	-2.350
PROBWTcl	-2.28528	0.4833	-4.728
PROBWTcl	-2.06033	0.5764	-3.574
PROBWTcl	-1.74219	0.4275	-4.075
PROBWTcl	-2.65316	0.6689	-3.966
PROBWTcl	-1.97849	0.5771	-3.428
PROBWTcl	-1.12213	0.6940	-1.617

Individual Probability Weights (Multivariate Logit Transform)

	Coefficient	Std. Err.	T-Score
PROBWTi	2.40853	1.0630	2.266
PROBWTi	3.67811	1.0477	3.511
PROBWTi	0.64433	1.3658	0.472
PROBWTi	2.35205	1.0292	2.285
PROBWTi	0.76943	1.3078	0.588
PROBWTi	-0.45115	1.2807	-0.352
PROBWTi	-0.08372	2.1357	-0.039
PROBWTi	-3.17297	0.2974	-10.671
PROBWTi	-3.48060	1.3692	-2.542